TECHNOLOGY DEPARTMENT

Power Generation

and POWER PLANT ENGINEERING

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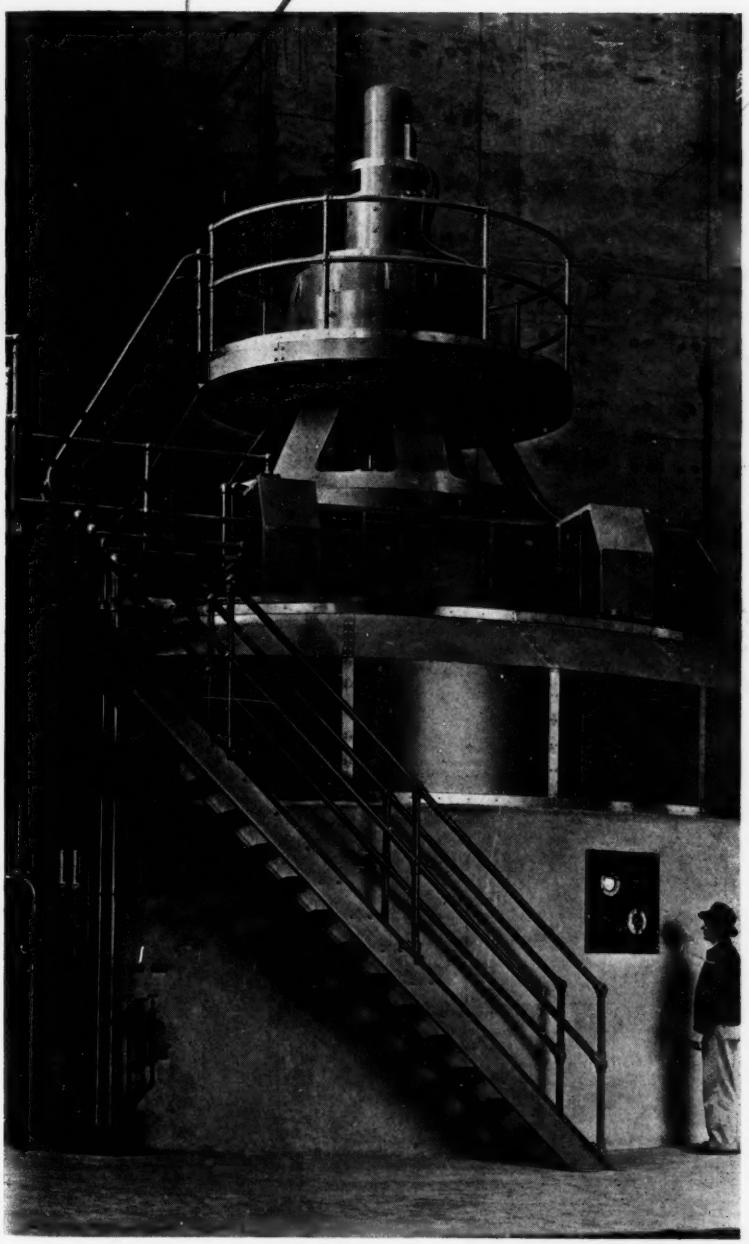

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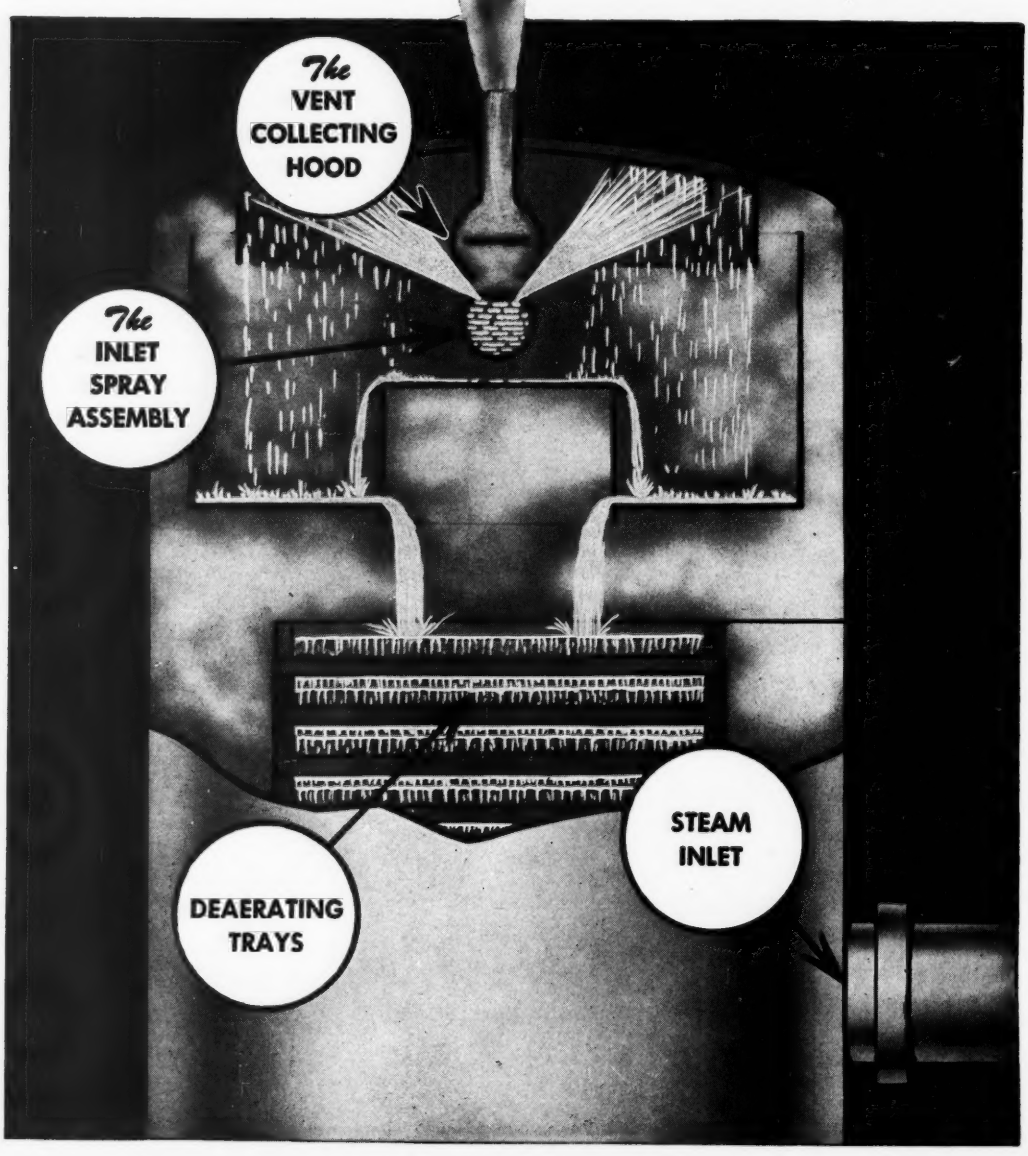
COVER: View of 12,000-kva, 6900-v, 150-rpm generator in power house at Drop No. 4 on the All-American Canal, Imperial Valley Irrigation District in Southern California (Elliott Co. photo)

For Power Engineers Responsible for Supply of Steam, Electricity and All Other Power Plant Services

THE *new* Elliott

EXIT CORROSIVE



ELLIOTT COMPANY PLANTS AT: JEANNETTE, PA.

SPRAY-TRAY DEAERATING HEATER

GASES

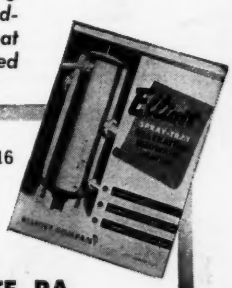
with no tubular vent condenser, no corrosion of parts, no maintenance.

The operation of the new Elliott deaerating heater is simple. The incoming water, agitated and broken into sheets and droplets, falls through the steam flow rising to the top of the unit. Most of the heating occurs in the upper section, so that as the water reaches and passes through the deaerating trays it readily gives up its oxygen and other noncondensable gases, which are swept upward by the steam to the vent collecting hood. At this point the steam is condensed by the incoming water, while the noncondensable gases are forced out the vent.

The big advance in the new design is the elimination of the tubular vent condenser, which has been a main cause of maintenance. Headroom is lowered too, and some piping is eliminated. Furthermore, stainless steel is used in the vent collecting hood, baffles and trays. No undeaerated water contacts the steel shell.

With this unit Elliott engineering hits a new high in deaeration operating economies.

Besides the protection of deaeration, deaerating heaters are a good investment from the standpoint of efficient feedwater heating. They heat the water up to the temperature of the saturated steam supplied to the heater.



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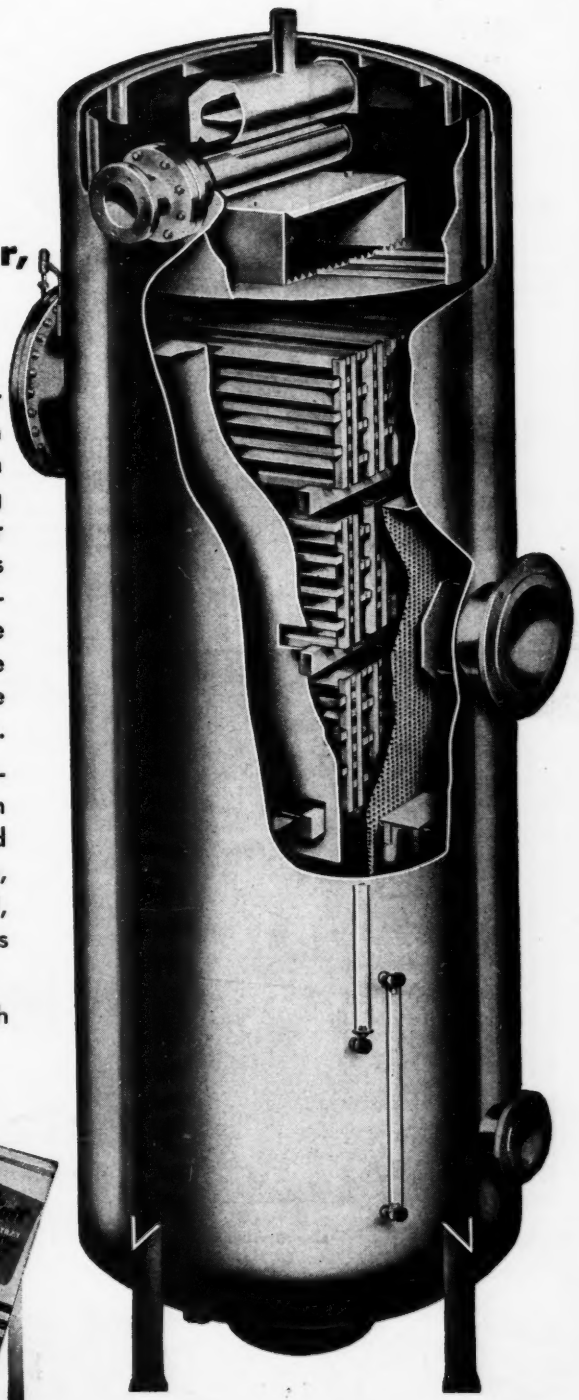


N-993

E, PA. RIDGWAY, PA. • SPRINGFIELD, O. • NEWARK, N. J. DISTRICT OFFICES IN PRINCIPAL CITIES

TEMPERATURE VARIATIONS, ABRASIVE SCALE NO PROBLEM WITH Edward BLOW-OFF VALVES

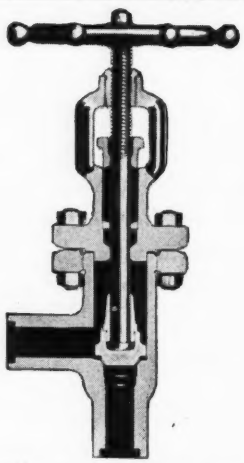
EASY OPERATION
Big knobbed handwheel, easy to grip even with oily hands.
LEAKPROOF BONNET
Welded integral or bolted, Edward blow-off bonnet joints won't leak.
PERFECT ALIGNMENT
Single set-up machining assures alignment of working parts.
ADJUSTMENT SIMPLE
Packing adjustment easy with through-bolted gland.
WEAR RESISTANT
Alloy seats and disks Stellite hard faced. (Stainless steel in lower pressures)
STREAMLINED
Nothing to prevent scale being blown completely through valve.
EQUALIZED CROSS-SECTIONS
No irregular masses of metal to distort on heating and cooling.

The vicious punishment of blow-off valve service—abrasive action of grit and scale—severe strains caused by violent temperature swings—finds its match in Edward blow-off valves.

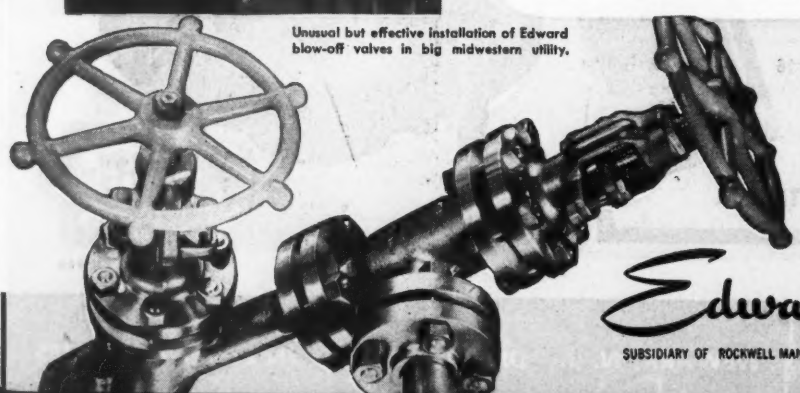
Special hard surfacing equipment, developed at Edward, prepares seats and disks for a long life of resistance to the grinding wear of sediment blown through the valve at high velocities.

Metal sections of Edward blow-off valve bodies are engineered to compensate for the thermal distortion so that a valve closed tight under high boiler temperature is still tight after cooling.

LOW MAINTENANCE
PIPING FLEXIBILITY
SLOW OPENING
EASY REPACKING
TIGHT CLOSURE
LONG LIFE



Typical Edward angle bolted bonnet blow-off valve. Choice of straightway or angle designs gives maximum piping flexibility.



Unusual but effective installation of Edward blow-off valves in big midwestern utility.

Edward builds blow-off valves for 150 lb to 2500 lb b service. Write for Catalog 12-D.

Edward Valves, Inc.

SUBSIDIARY OF ROCKWELL MANUFACTURING CO EAST CHICAGO, INDIANA

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Power Generation

November, 1948

VOLUME 52—NUMBER 11

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Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

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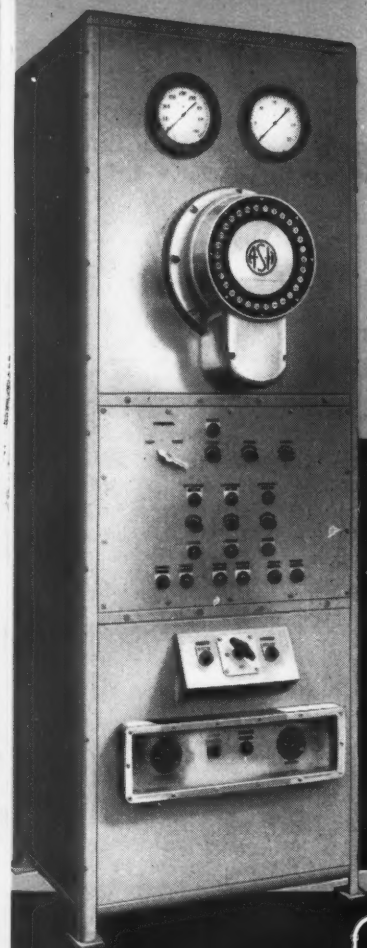
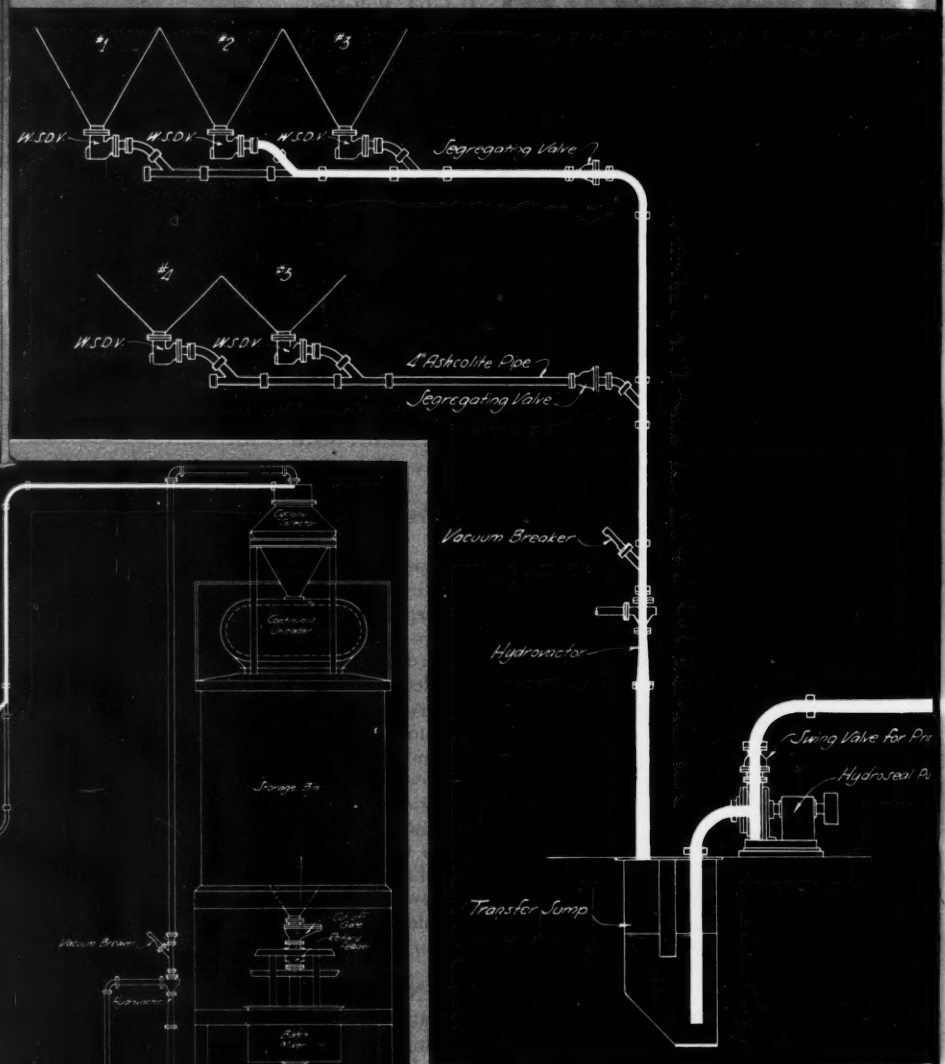
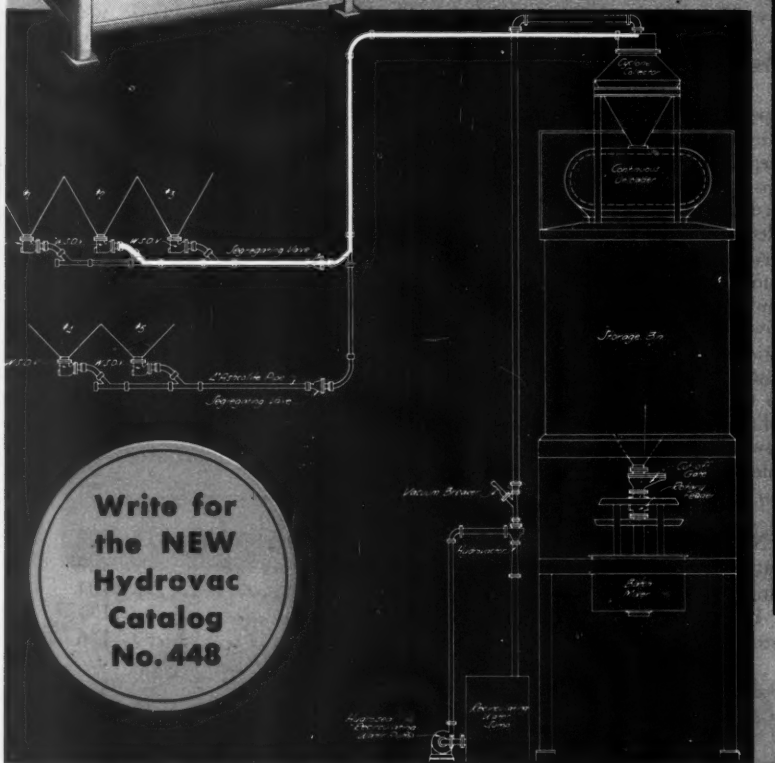
Entered as second class matter February 10, 1948 (original entry May 1, 1908), at the Post Office, Chicago, Illinois, under act of March 3, 1879.

Automatic Dust Handling Not a Luxury For Any Size Plant! It Pays Its Way

Push Button Dust Handling with the Automatic Sequence Hydrovac saves enough in operating time, attendance and maintenance to liquidate its additional cost over a hand operated Hydrovac System in a very short time. Liquid, wetted and dry dust disposal methods, developed by A-S-H, suit every plant condition. May our representative explain what "Automatic Sequence Hydrovac" can DO and SAVE for YOU?







Write for the NEW Hydrovac Catalog No. 448

Above, dust and vacuum producing water discharging into sump, then pumped to distant lowlands for fill by A-S-H Hydroseal Ash Pump.

Left, dust collected and stored dry, then partially fed into A-S-H Automatic Batch Mi which discharges wetted dust into cars or tru

ALLEN-SHERMAN-HOFF CO., 233 S. 15th ST., PHILADELPHIA 2, PA. Offices & Representatives in Principal Cities

ENGINEERS' PREVIEW

PULL-E-E-E-ZE! mister, don't whip us any more with that 6-ft bull whip tipped with steel prongs! We'll never do it again! We knew better all the time. Of course blast furnace gas does not normally escape into the air (Engineer's Preview, page 7, September). After cleaning (a story in itself) part of it goes to the stoves, which are regenerators or heat exchangers for heating up the input air for the furnace; and virtually all the rest is used as fuel somewhere in the plant. Since the gas has about 25 per cent CO of 85-105 Btu per cu ft, that's a lot of Btu's in the enormous volumes of gas handled. So they don't waste it. We knew all the time they didn't and we can't explain why we let that crack get through. Didn't you ever do something wrong when you knew better all the time? If so, then pull-e-e-ze! stop beating us with that bull whip!

★ ★ ★

HOW NICKEL STEELS were given severe impact tests at minus 320 F, is told with complete technical details in the June, 1948, issue of *Nickel Topics*. The Development and Research Division of the International Nickel Co. and engineers of the Air Reduction Co. Apparatus Research Laboratory, had five pressure vessels constructed to designs of M. W. Kellogg Co., incorporating most of the features of full-sized commercial vessels.

Each was approximately 3½ ft. long overall, with an outside diameter of 12½ in. and wall thickness of $\frac{5}{16}$ in. Vessels differed only in the base materials and welding rod used and the heat treating and stress-relieving involved. Three of the vessels were 8½ per cent nickel and one of carbon steel, all made by Lukens Steel Co. One was of stainless steel furnished by Crucible Steel Co. The heads were hot spun by Lukens and the tanks fabricated by Alloy Fabricators, Inc.

Heat treatments were given before and after fabrication. All major joints were completely X-rayed and vessels were all subject to 700 psi hydrostatic test for 15 minutes. In making the low temperature tests, the vessels were kept filled with liquid nitrogen at all times to maintain minus 320 F. In a special testing device, a weight of 292.9 pounds was dropped on all the alloy steel vessels from a height of 5 ft, but a smaller weight was used on the carbon steel vessel. The 8½ per-cent nickel and the stainless steel vessels withstood all tests without trace of fracture. The carbon steel vessel shattered and cracked badly on the first blow.

★ ★ ★

A FEW DAYS after we sent to press the details of the magnetic recording endless-belt type dictating machine, (page 129 August issue) a representative of the Dictaphone Co. called on us to demonstrate an endless-belt type machine recently developed by his company. This makes the recording not by magnetic methods but by mechanical methods on an endless belt of plastic material. This design, it is stated, was developed during the war for various military uses, and is now available, of course, for standard office dictating purposes, as well as for recording of telephoned instructions, dispatching procedures and industrial process instructions. For the latter use, special machines have been developed so that recordings for long periods of time can be made.

ENGINEERS' COUNCIL for Professional Development has recently issued its Fifteenth Annual Report. This includes the charter and rules of procedure, a report by the chairman, James W. Parker, followed by reports of the committees on Student Selection and Guidance, Engineering Schools, Professional Training, Professional Recognition, Information, Engineering Ethics and reports on Constituent Organizations. A list is given of the accredited undergraduate engineering curricula in the United States and Canada and a list of the accredited programs of the technical institute type. The report closes with a list of the ECPD officers and personnel for 1947-1948.

Each of the committee reports indicates progress in furthering the ideals of the engineering profession. The accrediting of curricula in the engineering colleges is being actively resumed following the disruption caused by the war. Investigations of the technical institutes, wherein no degrees are granted, is relatively new but a much-needed field for ECPD activity. Increased attention is being given to the selection of the right type of student for the engineering colleges. Copies of the complete report may be obtained for 50 cents each from the Engineers' Council for Professional Development, 29 W. 39th Street, New York 18.

★ ★ ★

EVEN SMALL GAINS in efficiency of internal combustion and particularly gasoline automobile engines can mean much to our domestic economy when it is recalled that spark ignition engines are now consuming gasoline at the rate of approximately 2,400,000 barrels per day and that there were serious local fuel shortages in some parts of the United States during the past winter. In view of these facts, high-compression engines promise large gains in fuel economy if high-octane gasoline can be made available at reasonable cost. The various factors in doing this, together with the development of engines having compression ratios of 12 or more to 1 were presented recently in a paper on "Increasing the Thermal Efficiencies of Internal Combustion Engines" by Campbell, Caris and Withrow of the General Motors Research Laboratories Division. With compression ratios of 12 or more to 1 and use of selected or higher octane fuels, the thermal efficiencies they reported would go as high as 40 per cent.

★ ★ ★

AMERICA'S amazing gains in productivity during the past century are attributed to the most lavish use of energy the world has ever seen. Through the unparalleled use of mineral energy, we now produce 29 times more goods and services than we did a century ago with only 5½ times as much human effort. Machinery and investment, rather than efficiency of labor and management, are the most crucial factors in increasing American productivity, according to the current Public Affairs Pamphlet entitled Power, Machines and Plenty, just released. A detailed discussion of all the factors involved in productivity, such as capital investment and inventions, industrial relations and the variations in the business cycle are given in this pamphlet by Gloria Waldron and J. Frederic Dewhurst. Copies of the pamphlet, which is No. 142 in its series, may be obtained from Public Affairs Committee, Inc., 22 E. 38th Street, New York 16, for 20 cents.

MEMBERS of the various engineering societies and technical bodies holding annual meetings and conventions should be interested in, and impressed by, the following rules for professional sessions printed in the program of the 1948 Semi-Annual Meeting of the ASH&VE at Bretton Woods, N. H. June 20-23:

1. At professional sessions each paper shall be read in abstract, 10 min. being allowed to the author for the presentation, unless otherwise authorized by the meeting.

2. A member who has given notice of his intention to discuss a paper and has reduced his discussion to writing may be allowed 5 min. for its presentation.

3. Each speaker shall be limited to 5 min. in the oral discussion of a paper, unless the time shall be extended by action of the meeting. A member who has once had the floor may not again claim it until all others who desire to speak on that paper have been heard.

4. Authors of papers may have 5 min. to close the discussion on the paper.

★ ★ ★

CONCENTRATING FRUIT JUICES by refrigeration, rather than by steam, is a new technique recently put into operation by the Florida Citrus Canners Cooperative at Lake Wales. In this process, a refrigerating machine instead of a boiler is used to heat the citrus juice and drive off the excess water, while the same refrigerating machine simultaneously cools and condenses the water vapor under a vacuum. The heat balance in this closed cycle is very good, only 70 gpm of water being needed to carry away heat through a small supplementary condenser. The process is based on nearly twenty years of work by J. L. Heid, now director of research and development for the Cooperative. He formerly worked in U. S. Government Laboratories in California and Florida and, along with others, improved methods of concentrating citrus juices at low pressures. Then the firm of Mojonnier Brothers Co. was called in to work out the evaporating process and the Frick Co. to supply the equipment. It is claimed that the process is equally applicable to concentrating milk, pharmaceuticals, and many chemicals and even liquid eggs. Cooling water requirements are low and the cycle can also be used for distillation.

★ ★ ★

NATION-WIDE industrial survey of high prices, based on increased production and transportation costs, will be undertaken by the distribution committee of the ASME, it was announced by Fenton B. Turck, chairman of the committee. Describing the distribution of industrial production as "now America's primary domestic problem," Mr. Turck said his committee would be solely concerned with the assembly of factual material on the subject and invites the cooperation of qualified companies and organizations. The survey is scheduled for completion this year, and will be available on request. It is believed it will be of interest to all manufacturers and consumers.

The Supreme Court's recent cement decision can influence the pricing policies of many American industrial organizations, Mr. Turck pointed out. This decision now calls for factory priced products, or f.o.b. billing. In addition, our total distribution system is now faced with rapidly increasing transportation costs. Indicated changes in the American distribution system, he said, concern the stability of employment in the nation's 33 major industrial centers and even the daily diet and standard of living of consumers.

NEW HORMONE preparation to prevent sterility has been discovered by Professor Axel Westman, according to reports in the Swedish press. This, it is explained, holds promise of affording relief for many childless marriages. A number of engineers, to whom we have mentioned this, react somewhat as follows: "Well, Professor Westman shouldn't be encouraged right now, because what the world needs is fewer and better people, not more people. It might be a good idea to have him develop his discovery and hold it in reserve for some time in the future when the world might need to increase its population for some reason."

★ ★ ★

TO BACK UP one of the largest hydroelectric systems in the world, a thermal power plant of approximately 300,000 kw capacity is to be built at Windsor, Ontario, Canada by the Hydro-electric Power Commission of Ontario. The first installation will include two 80,000-kw steam turbine generators.

The plant will be on the outskirts of Windsor and will be on the Detroit River opposite the area served by The Detroit Edison Co. Consequently an interconnection with the latter will be relatively simple if it is desired. Coal for the new station will be delivered by lake boats from the United States.

The new plant will, of course, use 60-cycle generators, therefore its construction and operation may be delayed somewhat until the Windsor area can be converted from its present 25 cycle system; this may take three or four years.

★ ★ ★

STATISTICAL BULLETIN 1947 of the Electric Light and Power Industry in the United States, Number 15, has recently been issued as Publication No. Q2 by Edison Electric Institute, 420 Lexington Avenue, New York 17. This includes detailed data and tabulations of generating capacity in kilowatts, generation in kilowatt hours, fuel used, construction expenditures, sales and revenue and financial statistics of the electric utility companies.

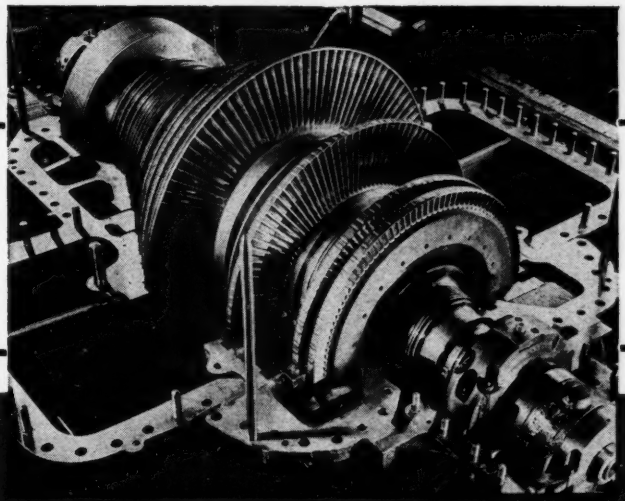
★ ★ ★

MONOSODIUM GLUTAMATE is a name that chemists and engineers are becoming increasingly familiar with. It is a seasoning, long known to the Orient, and it has no flavor of its own, but brings out the flavor of many other foods. New facilities are completed or under construction to produce essentially identical glutamate from corn and wheat gluten and desugared beet molasses, and capacity for production is expected to increase to about 12,000,000 lb, according to the *Industrial Bulletin*.

★ ★ ★

TO SUPERVISE the electric power aid program under the Economic Co-operation Administration, Walker L. Cisler, executive vice president of The Detroit Edison Co., has been named consultant to Administrator Paul Hoffman of ECA. In turn, Mr. Cisler has appointed C. W. DeForest as his deputy to handle the work in Paris, France. During the late years of World War II and immediately thereafter, Mr. Cisler headed the military government section on public utility in Europe. When he returned to civil life he was replaced by Mr. DeForest, who left his retirement to supervise the utility reconstruction in areas controlled by United States troops.

KEEP TURBINES ON THE LINE



your margin of

safety is greater with Texaco Regal Oils (R&O)

IT'S serious, these days, when turbines have to come off the line at unscheduled times. So make sure your turbine oil gives full protection. Use *Texaco Regal Oils* (*R & O*). They assure an extra margin of safety—even under today's heavy power demands.

Texaco Regal Oils (*R & O*) contain additives to inhibit rust and oxidation, and are especially processed to prevent foaming. Throughout their extra long service life they keep turbine lubricating systems clean . . . bearing temperatures normal . . . governor action instantly responsive.

Turbine manufacturers recommend the use of inhibited oils—and *Texaco Regal Oils* (*R & O*) meet the stringent requirements of all leading turbine builders . . . as well as the turbine oil specifications of the U. S. Navy.

Let a Texaco Lubrication Engineer help you operate *all* your power plant machinery more efficiently and economically. Just call the nearest of the more than 2300 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Regal Oils (R&O)

FOR ALL TURBINES

Tune in...Texaco Star Theatre every Wednesday night starring Milton Berle. See newspaper for time and station.

for EVERY

Yarway Type "B" angle-straightway Seatless Tandem Valve with balanced sliding plungers. Flanged, steel body.
TO 400 PSI
TO 600 PSI

THERE'S A YARWAY BLOW-OFF VALVE

Yarway offers boiler plant operators a complete Blow-Off Valve Service—distinct types of valves to meet the blow-down requirements of every steam plant.

These valves are the products of 40 years mechanical and metallurgical research—of practical field experience with thousands of installations—of experiments and testing in Yarway's own unique Steam Laboratory—and of a determination continually to lead the industry with the finest blow-down equipment that can be produced.

Because the Yarway line is complete you may be sure Yarway recommendations are based on experienced judgment that the type of valve selected will give long, trouble-free, money-saving service.

WRITE TO YARWAY FOR FREE BLOW-OFF VALVE BULLETINS. STATE YOUR BOILER PRESSURE.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY BLOW-OFF

PRESSURE

Yarway Steel Seatless Valve combining a Yarway Steel Seat Valve (for blowing) and a Yarway Seatless Valve (for sealing) in a Monobloy forged steel body. Flanged connections shown. Two Hard-Seat Valves furnished if desired.

TO 2500 PSI

A Few Representative Users

OF YARWAY BLOW-OFF VALVES

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Public Service Electric & Gas Co.
Virginia Power & Light Co.
Lansing Generating Station
Pacific Gas & Electric Co.
Philadelphia Electric Co.
Boston Edison Co.
Pennsylvania Power & Light Co.
Georgia Power Co.
Cleveland Elec. Illuminating Co.
Connecticut Light & Power Co.
Indiana-Michigan Power Co.

INSTITUTIONS

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Harvard Medical School
Florida State Hospital
California State Hospital
University of Chicago
Cornell University
Kentucky State Hospital
Iowa State College

INDUSTRIAL PLANTS

Norton Company
Mansfield Tire & Rubber Co.
Springs Cotton Mills
Celanese Corp.
R. J. Reynolds Tobacco Co.
Eastman Kodak Co.
Armour & Co.
American Viscose Co.
Lever Bros. Co.
Armstrong Cork Co.
Bethlehem Steel Co.

Forty Years SERVICE
1908 1948
TO STEAM PLANTS

YARWAY SEATLESS ANGLE VALVE

Cross section of valve in open position. Notice balanced sliding plunger design. Plunger is nitrided steel, extremely wear-resistant.

YARWAY HARD-SEAT STRAIGHTWAY VALVE

Cross section of valve in open position. Stellited disc and seat. A worthy companion to the Yarway Seatless Valve for tandem use on higher pressure.

F VALVES

ASSURE
low cost steam
with the
C-E Package Boiler

In more than a score of widely varying industries the C-E Package Boiler is providing low-cost steam — piling up a record of efficiency and economy that is the direct result of service-proved design.

What is this proved design? It is a complete coordination of boiler, furnace and fuel burning equipment — every component in balanced relationship, correctly proportioned for maximum performance at minimum cost.

Among the more important features of the design is the fact that not only the furnace wall tubes but 65 per cent of the surface of the first four rows of boiler tubes in the first pass "sees" the fire. This unusually high percentage of radiant-heat absorbing surface makes the C-E Package Boiler a most rapid and efficient steam producer. At the same time, the completely water-cooled furnace reduces refractory maintenance to a practical minimum.

Nor is the performance of this boiler dependent on one kind of fuel or one type of firing. You may use the firing method best suited to your fuel and load conditions — oil, gas, or stokers (either underfeed or spreader type). Moreover, one method may easily be substituted for another if a change occurs in your local fuel situation.

C-E Package Boiler balanced design is standardized in a range of sizes having capacities from 15,000 to 50,000 lb of steam per hr. This standardization not only assures you top performance in a size that fits your needs, but gives you added savings in lower engineering and installation costs.

For your new steam plant or in the extension or modernization of your present facilities, why not assure yourself of low-cost steam by doing as others have done in industry after industry — buy the C-E Package Boiler.

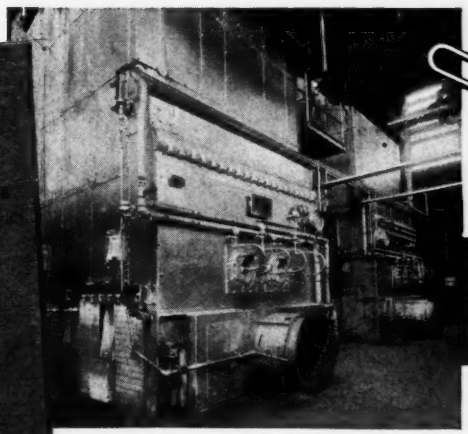
B-263

COMBUSTION

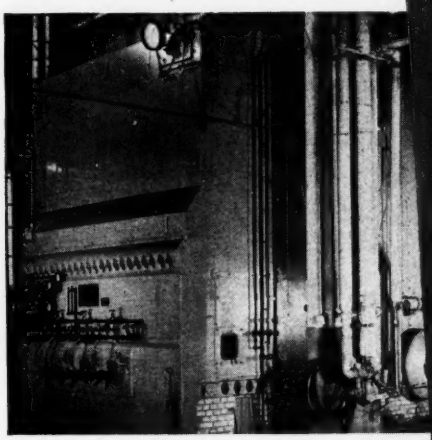
C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS. ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

for your plant

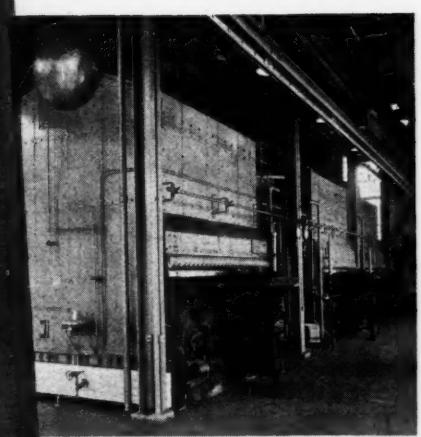
C-E Package Boiler fired by C-E Spreader Stoker. Max. continuous capacity — 41,500 lb steam per hr, oper. press. — 150 psi, furnace width — 13 ft 6 in. (in West Virginia)



Two C-E Package Boilers fired with oil. Max. continuous capacity — 26,700 lb steam per hr, oper. press. — 200 psi, furnace width 9 ft 0 in. (in Delaware)



C-E Package Boiler fired with oil. Max. continuous capacity — 31,500 lb steam per hr, oper. press. — 150 psi, furnace width 10 ft 6 in. (in New York)



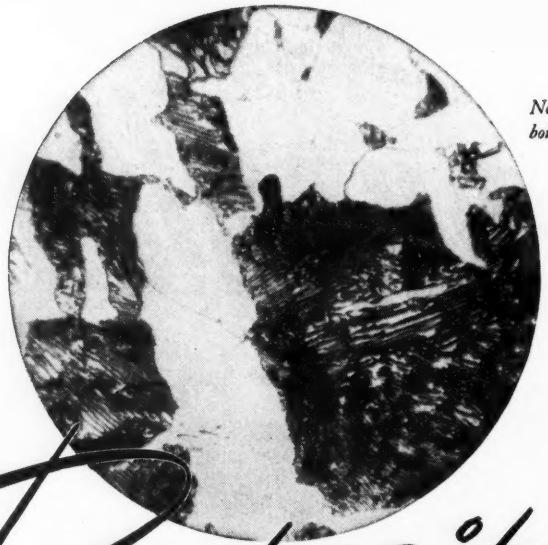
Three C-E Package Boilers fired by Type E Stokers. Max. continuous capacity — 36,000 lb steam per hr, oper. press. — 125 psi, furnace width 12 ft 0 in. (in Ohio)

PARTIAL LIST OF INDUSTRIES THAT HAVE SELECTED THE C-E PACKAGE BOILER

AUTOMOBILE
BAKERY
CHEMICAL
COLD STORAGE
DAIRY
GLASS
HOSIERY
HOSPITAL
INSTITUTIONS
LEATHER
LINOLEUM
MACHINERY
METALS
OIL
PACKING
PAINTS
PAPER
RAILROADS
RUBBER
STEEL
SUGAR
TEXTILE
TOBACCO
UTILITY

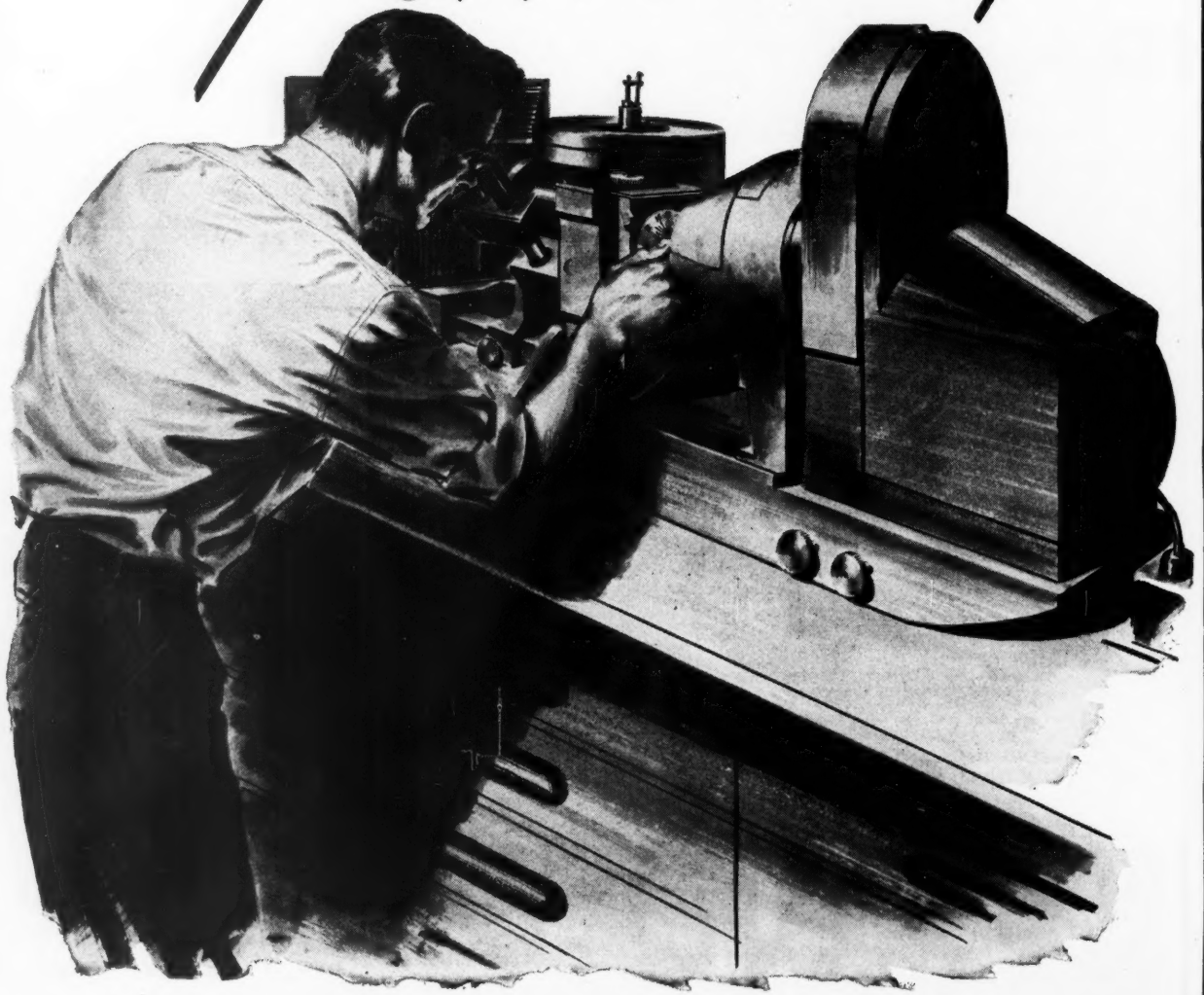
ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.



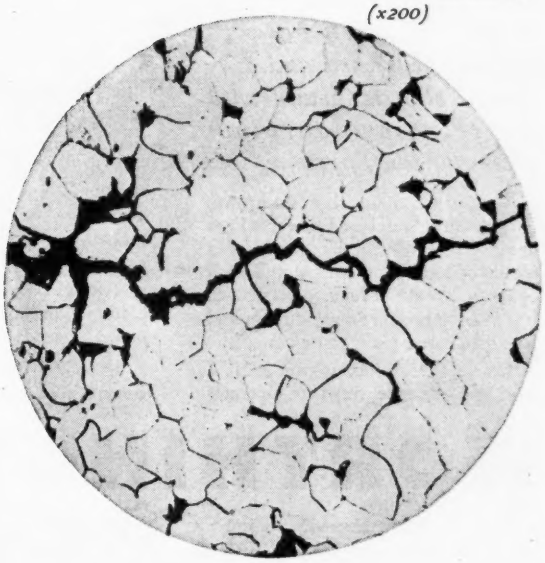
Normal low-carbon boiler steel (×1000)

Portraits of



Metallic structure of overheated tube which has been quenched (x200)

Typical intergranular crack caused by caustic embrittlement (x200)



Trouble

Many kinds of boiler metal trouble leave distinctive marks in the structure of the metal itself, and in many cases, these traces are an important clue—if not the only clue—to the exact nature of the trouble.

That's why the metallographic microscope is so important a tool in Hall Laboratories. Samples of metal cut from failed tubes or other damaged boiler metal parts are carefully polished and etched, then studied under this microscope. Photomicrographs, at suitable magnification—up to two thousand times if required—may be taken for further study.

This kind of metallographic examination may show, for example, whether a tube failure is due to transcrystalline stress corrosion cracking, or to intergranular caustic or hydrogen embrittlement. It provides positive evidence when overheating has occurred, and many times gives corroborative evidence which supplements the facts gained from chemical and other methods of analysis.

Metallographic examination is only one aspect of the careful study Hall Laboratories devotes to your boiler problems—and this careful study is one reason why so many plants, of all sizes, in all parts of the country use Hall service.

Hall Laboratories, Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

HAGAN
HALL
BUROMIN
CALGON

HOW TO KEEP PURCHASED POWER UNDER CONTROL...

Ohio leather manufacturer keeps efficient balance between generated and purchased electric power with Worthington turbine-generator unit.

At the Ohio Leather Company, Girard, Ohio, purchased power is kept under direct control by means of a steam turbine generator unit which operates as a "reducing valve" to bring boiler pressure down to required levels for use in plant processes.

The turbine, a Worthington 750 KW straight non-condensing type, operates in parallel with the source of purchased power and has an automatic governor control responsive to both purchased or primary power and to plant demands for processing steam. This results in:

- limiting the *maximum* demands on purchased power to a predetermined top level, regardless of plant steam demands.
- limiting the minimum demands to a level which will prevent return flow of power to primary source when plant steam demands are high and power demands low.

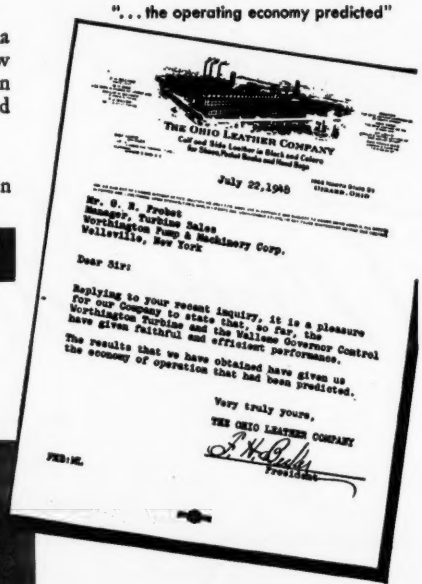
SAVE WITH WORTHINGTON

Savings to date on this installation are at a rate indicating 100% return on the initial investment in three years! For further details that prove *there's more worth in Worthington*, call your nearest Worthington District Office . . . or write direct to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.*

WORTHINGTON

STEAM TURBINES

"... the operating economy predicted"



THE OHIO LEATHER COMPANY

July 22, 1948

Mr. G. B. Probst
Manager, Turbine Sales
Worthington Pump & Machinery Corp.
Wellsville, New York

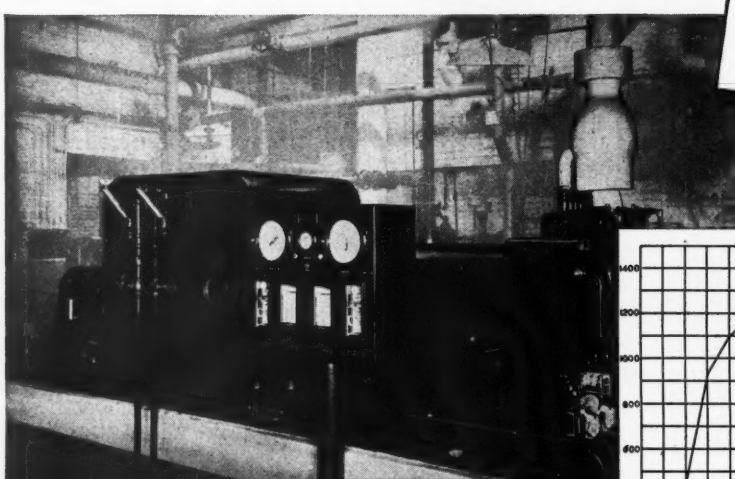
Dear Sir:

Replying to your recent inquiry, it is a pleasure for our Company to state that, so far, the Worthington Turbine and the Wallene Governor Control have given faithful and efficient performance.

The results that we have obtained have given us the economy of operation that had been predicted.

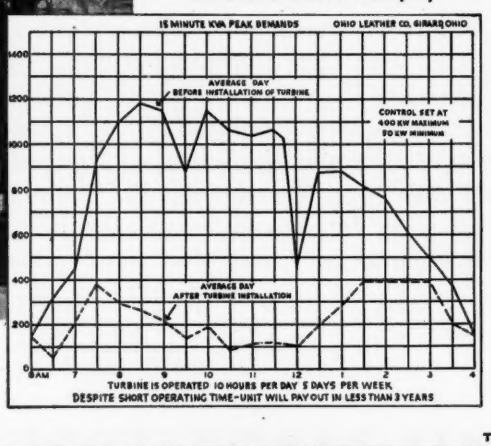
Very truly yours,
THE OHIO LEATHER COMPANY

PRES:MK.



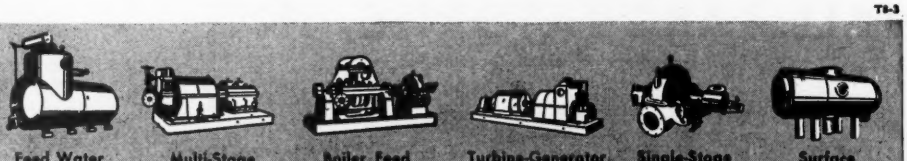
The Ohio Leather Company installation is a direct-connected turbine generator unit, 750 KW, 3600 rpm, 240 volt 3 phase 60 cycle. Steam conditions are 240 psi, 450° F, exhausting at 5 psig. Controls are by Wallene Engineering Co., Cleveland, Ohio.

"BEFORE AND AFTER"
... at the Ohio Leather Company



T8-3

A GREAT TEAM IN STEAM



BALANCE

You Can't Have Efficiency in Draft or Dust Collecting Equipment without it!

Balance . . . just as important in stack and dust collecting equipment as it is to a dancer. It costs needless time, money and effort, to try to get truly efficient operation from unrelated dust collecting and draft producing components obtained from different manufacturers.

Thermix packaged design flue gas control, balances and integrates the operation of: 1—dust collector, 2—fan, 3—breeching and 4—stack . . . provides predetermined efficiency . . . offers the added advantages of unit responsibility for draft production and dust collection.

These four important features of Thermix equipment, plus this unit design, unit manufacture and unit responsibility, protect your investment and assure operational savings for many years.

Details of Thermix equipment are available in a complete catalog. Write for a copy on your company letterhead.

All inquiries should be directed to:

Project & Sales Engineers

THE THERMIX CORPORATION

First National Bank Bldg. **Greenwich, Conn.**

(Offices in 28 principal cities)

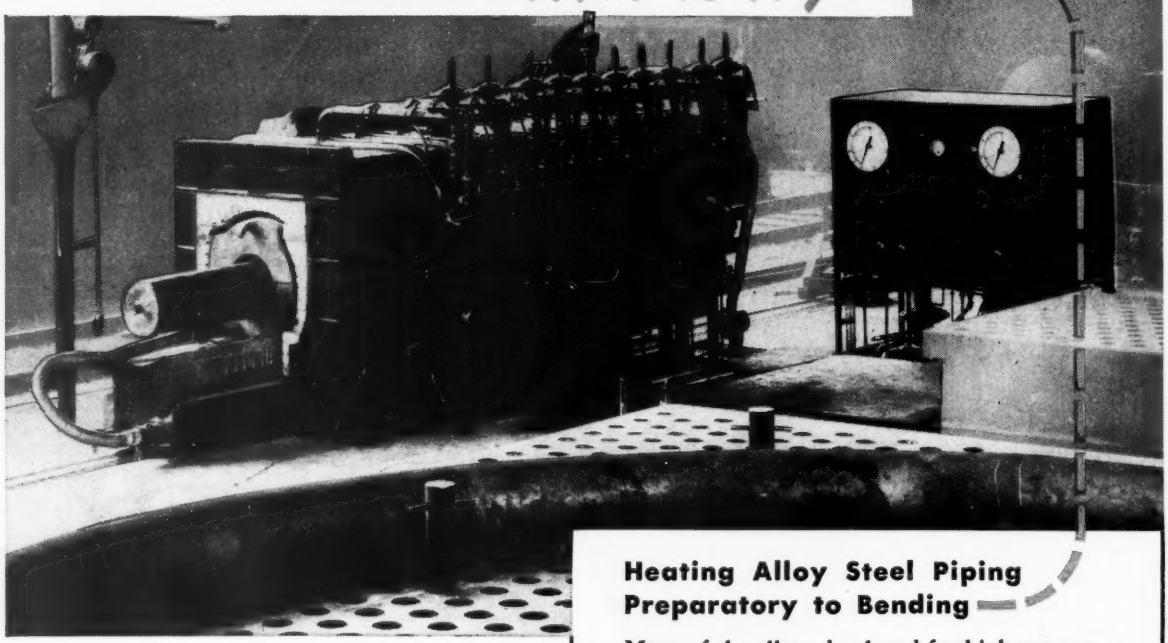
Canadian representative: T. C. CHOWN, Ltd., 1440 St. Catherine St. W., Montreal 25, Quebec

PRAT-DANIEL CORPORATION

Manufacturers of Thermix Equipment

EAST PORT CHESTER, CONN.

IF THERE EVER WAS A JOB FOR SPECIALISTS— *THIS IS IT!*



Heating Alloy Steel Piping Preparatory to Bending

Many of the alloys developed for high-pressure, high-temperature services and for corrosion-resistant applications are susceptible to loss of their valuable properties within certain temperature ranges as a result of excessive changes in metallurgical structure, surface oxidation, heat shock and cracking.

Only furnaces equipped to maintain accurately the specified temperature of the pipe are capable of retaining and safeguarding the metallurgical properties which dictate the choice of material.

Grinnell's modern pipe fabrication equipment includes specially designed gas-fired *radiant heat* furnaces, with such features as strategic location of multiple burners providing uniform temperature distribution and preventing harmful flame impingement, close temperature and time controls, automatic regulation, recording instrumentation and car loading.

Prefabricated Piping from GRINNELL assures you *QUALITY*

Grinnell interpretive engineering, metallurgical research, specialized facilities, skilled personnel and rigid inspection, assure delivery of pretested and certified piping sub-assemblies which meet all governing code requirements.

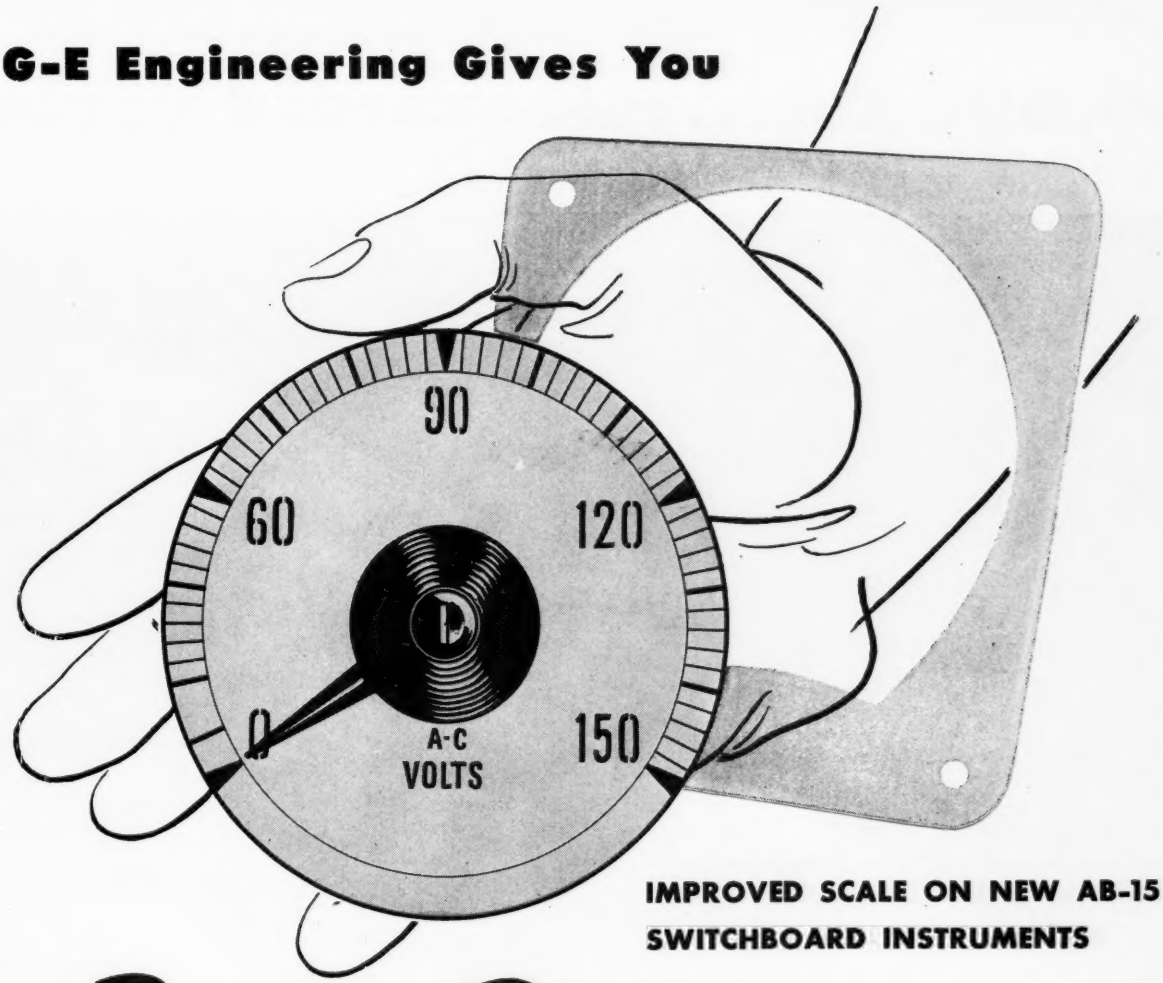
Prefabricated Piping from GRINNELL assures you *ECONOMY*

One source for design and fabrication. Coordination of shop production under ideal conditions. Predetermined but flexible delivery schedules. Elimination of waste by paying only for finished assemblies. Reduction in field assembly time.

GRINNELL COMPANY, INC. Providence 1, R. I.
Branch warehouses in principal cities.
Pipe Fabrication Plants: Cranston, R. I.; Warren, Ohio.

GRINNELL
WHENEVER PIPING IS INVOLVED

G-E Engineering Gives You

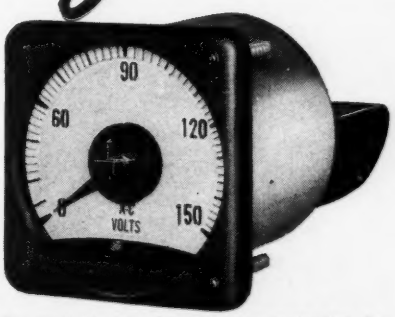


IMPROVED SCALE ON NEW AB-15 SWITCHBOARD INSTRUMENTS

Better Readability

Precise reading with the least effort. That's what you get with the new General Electric switchboard instruments. Here's why: (1) Long scale (7.1 inches) spans 250 degrees with all figures reading laterally instead of on a curve, (2) Circular mask covers mechanism at center of dial emphasizing pointer and figures, (3) Anti-parallax arrangement of pointer assures accurate indications from any reasonable angle, (4) Anti-glare glass minimizes reflections, (5) Accented main scale division lines simplify reading, (6) Over-all scale has been simplified by elimination of extraneous printing.

Other features like spring-mounted jewels, small size (only 4½ inches square), and "unit" design assure sturdiness, economy of space, and ease of service. Be sure of the best for your switchboard instruments. Insist on the new G-E long-scale instruments. GEC-218 gives details. Write for your copy today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

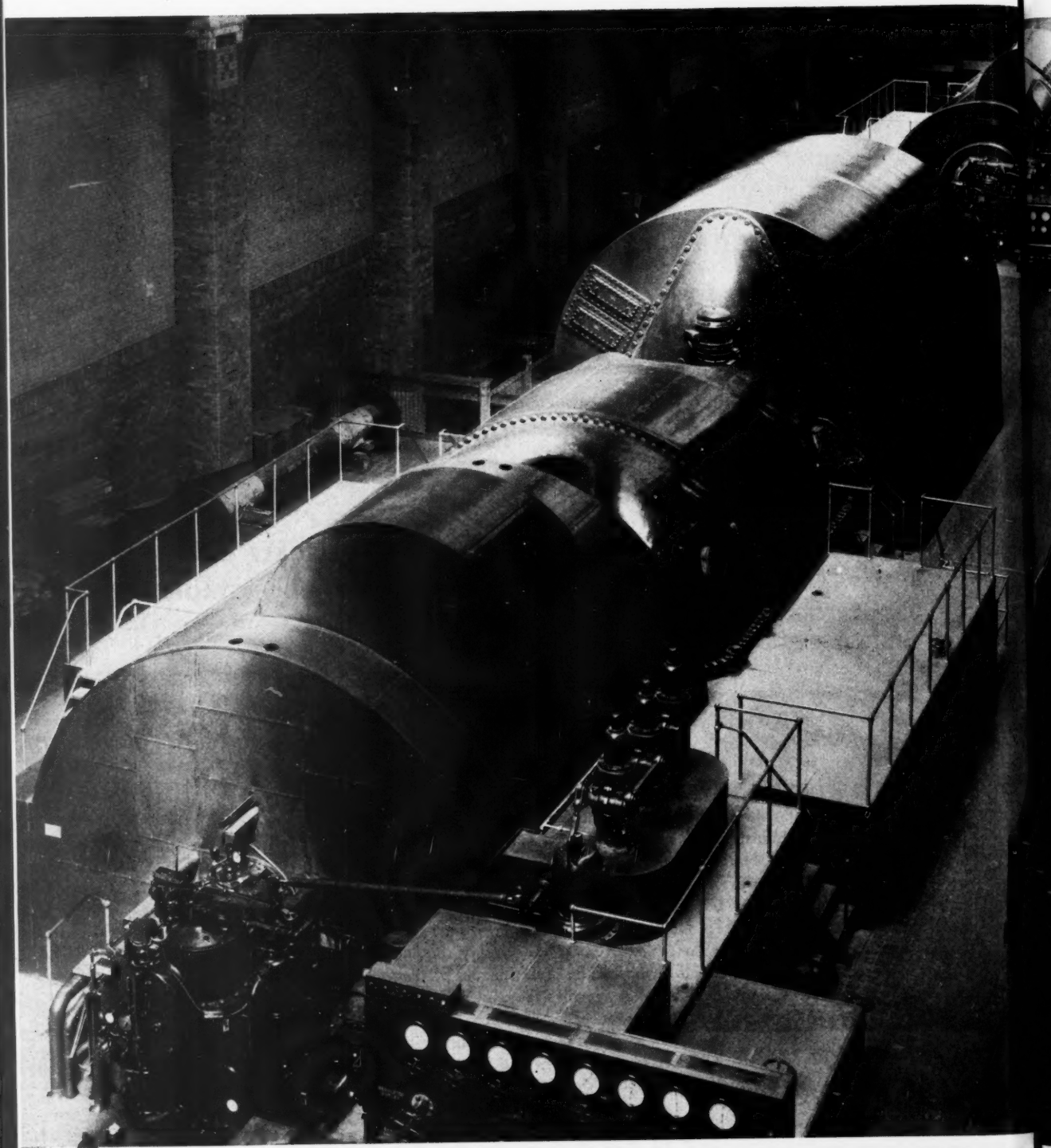


Also available as a-c ammeter, a-c wattmeter, d-c voltmeter, d-c ammeter, temperature indicator, power-factor meter, synchroscope, and frequency meter.

GENERAL ELECTRIC

602-128

160,000 KW... safeguarded against ou



STANDARD OIL COMPANY (INDIANA) ST

nst outages by

NONPAREIL
Turbine Oil

The two big turbines shown in the photograph at left have a total capacity of 160,000 KW. Outages for oil system maintenance have been eliminated on this large operation by Nonpareil Turbine Oil.

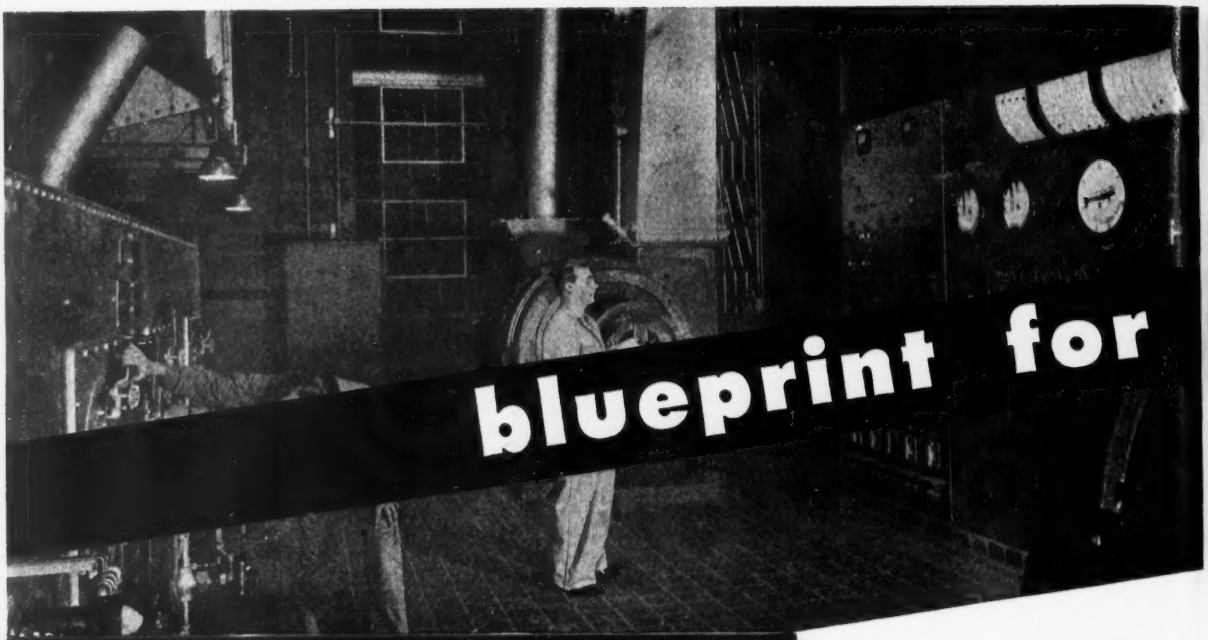
Oil acidity troubles have been avoided. The original fills of Nonpareil have not been removed for treating or resting in their respective five and six years of use. Nevertheless, neutralization numbers have stayed below 0.10 mg. KOH/gm.

Oil system maintenance has been eliminated. There has been no deterioration of the lubricant. The turbine oil systems have remained free from deposits.

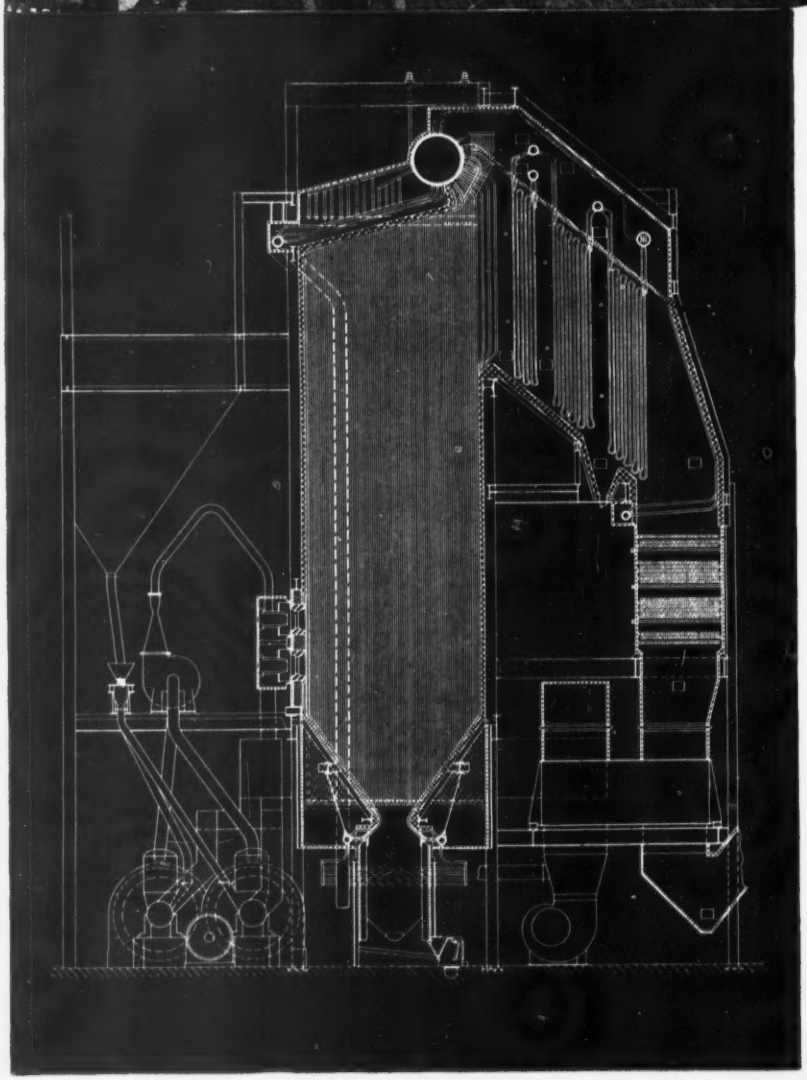
Nonpareil Turbine Oil provides this protection against outages, not for 5 or 10 or 20 years, but for the life of every turbine it lubricates. It is the only product in its field that carries a written guarantee that it will last as long as your turbine, without increasing in acidity above a neutralization number of 0.15 mg. KOH/gm.

Why not end oil acidity troubles and oil maintenance once and for all, by shifting your turbines to Nonpareil Turbine Oil. If your plant is located in the Midwest, write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the services of the Standard Oil Lubrication Engineer nearest you.

ANA) STANDARD OIL COMPANY (INDIANA) STANDARD



blueprint for



E. M. POSTON STATION
COLUMBUS AND SOUTHERN OHIO ELECTRIC COMPANY

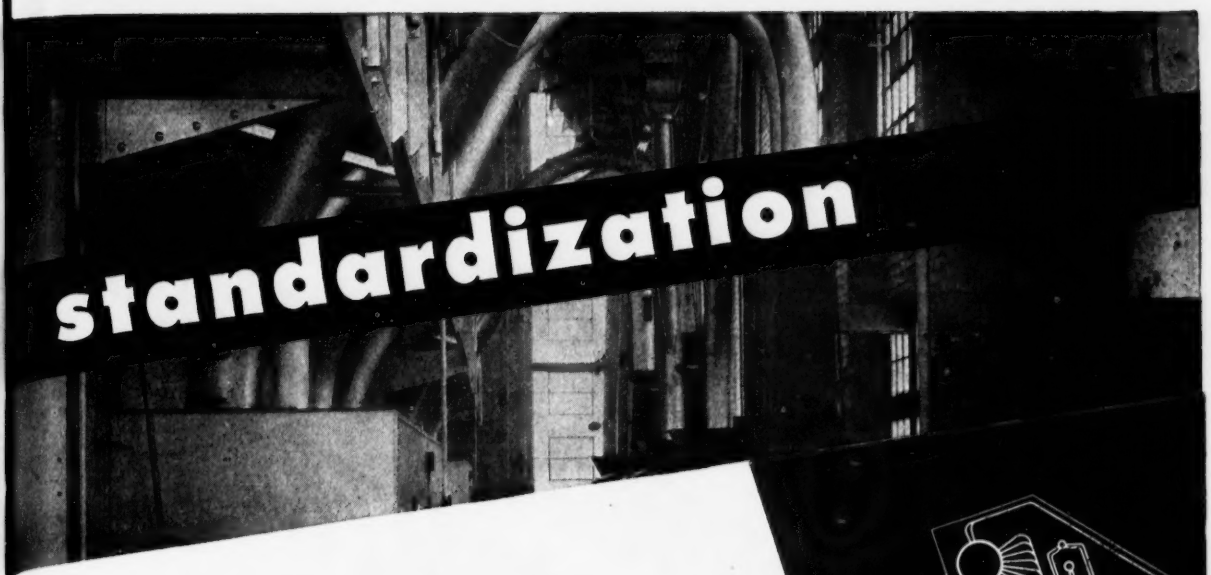
Steam Capacity
425,000 lb per hr

Superheat control range
300,000 to 425,000 lb per hr

Pressure superheater outlet
1354 psi

Final steam temperature
955 F

Bituminous Coal Pulverized
in FW Ball Mills



Standardized Steam Generating Equipment for Central Stations

Foster Wheeler has demonstrated outstanding leadership in developing central station equipment which helped the Utility Industry to achieve increased productivity. A large share of the credit can be directly ascribed to the FW line of single-pass, baffle-less steam generators having liberal furnace dimensions. This arrangement has been used as the basis for "Preferred Standard" steam generator designs which have been developed by Foster Wheeler Corporation for the Utility Industry.

Engineering and Manufacturing Costs Reduced

The "Preferred Standard" steam generator design (suggested on the right) promises substantial savings by the reduction of engineering and fabrication costs.

Fixed Individual Equipment Details

The unit being built for the E. M. Poston Station of the Columbus and Southern Ohio Electric Company is typical of the single-pass design which Foster Wheeler is using as the basis for "Preferred Standard" steam generators. This standardized steam generator pattern with fixed individual equipment details may be readily applied to a series of single or twin furnace units varying in capacity from 300,000 lb per hr to over 1,000,000 lb per hr.

Other Foster Wheeler Fuel and Labor Saving Features

The design also embodies Foster Wheeler features of slag-free furnace arrangement, Foster Wheeler condenser-type steam temperature control, minimum baffles, low draft loss, and efficient heat recovery arrangement. When additional furnace cooling is required, the "Preferred Standard" design may readily incorporate a water cooled division wall.

For additional information, write . . .

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

... Ask any User about DETROIT ROTOGRATE STOKERS That REVOLUTIONIZED COAL BURNING

RotoGrate Stoker with six grate sections as applied to a typical water cooled furnace of a steam generator. Two of the six Rotors are removed to show the overlapping grate design.

Some of these plants installed Detroit RotoGrate Stokers ten years ago. They have all used them for several years.

They can tell you:

1. RotoGrate is reliable — high availability.
2. Combustible loss in ash pit extremely low.
3. Burns any bituminous steam coal or lignite.
4. Burning rates higher — flexibility greater.
5. No clinker difficulties.
6. Little power to operate.

Investigate the RotoGrate — the *original* spreader stoker with *forward* moving grates that slowly and continuously discharge the ash at the *front*. Operation is fully automatic.

TYPICAL USERS of DETROIT ROTOGRATE Stokers

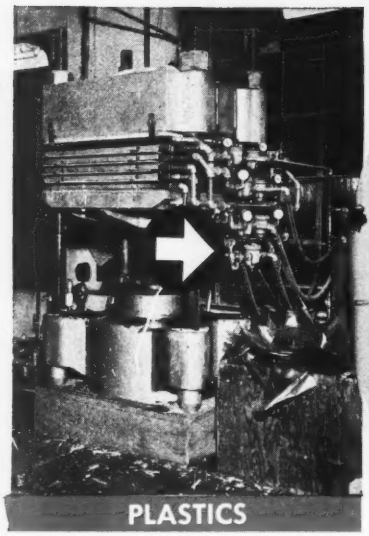
Rath Packing Co.
Central Illinois Electric & Gas Co.
Pontiac State Hospital
J. I. Case Co.
Studebaker Corporation
Falk Corporation
Northwest Paper Co.
Wyandotte Municipal Plant
General Motors Corporation
American Box Board Co.
Consolidated Paper Co.
Sioux City Gas and Electric
Chrysler Corporation
Goodyear—St. Mary's Division
Motor Wheel Corporation
American Steel Foundries
Wyman Gordon Co.
American Distilling Co.
State University of Iowa
Northern States Power Co.
Great Western Sugar Company
Cudahy Brothers
West Virginia Pulp & Paper Co.
International Harvester Co.
National Forge and Ordnance Co.
Muscatine Municipal Plant
Chesapeake & Ohio Railway Co.
Ohio Rubber Co.
Borden Co.
Oscar Mayer & Co.

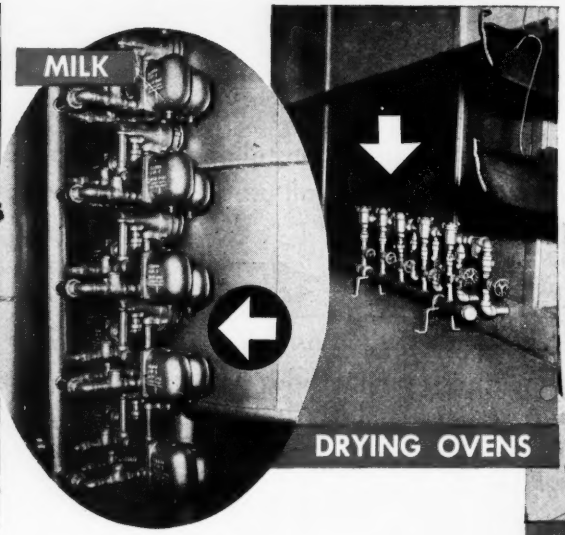
DETROIT ROTOGRATE STOKER

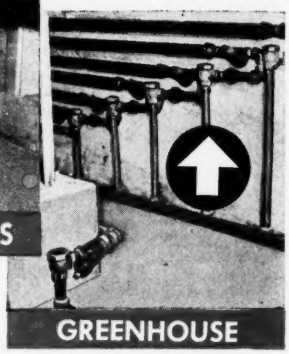
DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

WORKS AT MONROE, MICHIGAN • DISTRICT OFFICES IN PRINCIPAL CITIES







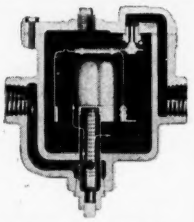
ALL-OUT HEAT USERS -*All Sarco*

When you buy steam traps, it pays to use just as many as necessary to assure efficient drainage and venting of every individual unit.

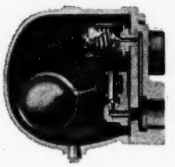
That's why you see so many batteries of Sarco Steam Traps. Each of the four types illustrated has special advantages of its own. All have the "know how" of Sarco's experience and the precision that results from being made in a plant devoted exclusively to steam traps and temperature controls.

FOR THE SMALL PLANT TOO

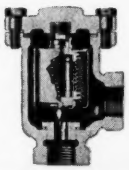
Small plants can profit by this advanced knowledge merely by asking for a Sarco recommendation. Your heating engineer or the nearest Sarco Representative can get this for you. And don't overlook the various forms of Sarco hot water, process and cooling controls.



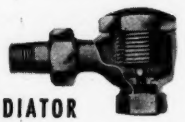
BUCKET TRAP



FLOAT-THERMOSTATIC



THERMOSTATIC



RADIATOR TRAP

240

SARCO

SAVES STEAM

SARCO COMPANY, INC.

Represented in Principal Cities

Empire State Building, New York 1, N. Y.

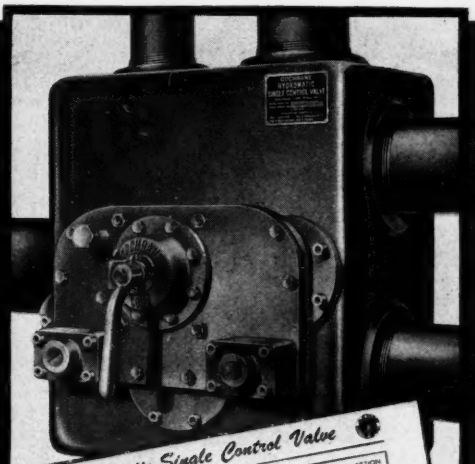
SARCO CANADA, LTD., TORONTO 5, ONTARIO

Now Available COCHRANE

ZEOLITE SOFTENERS & FILTERS

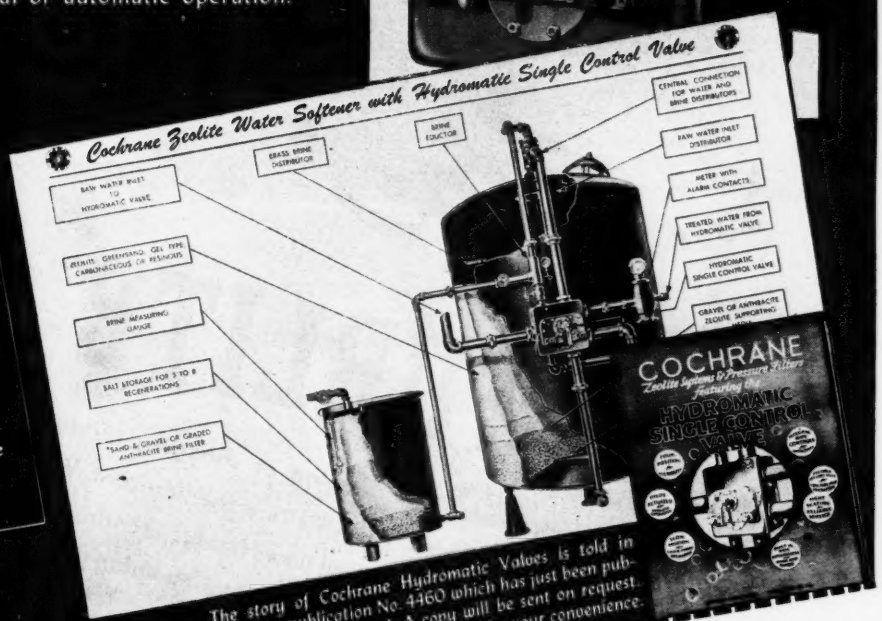
with HYDROMATIC SINGLE CONTROL VALVE

Simplifying valve operations by integrating the functions of the usual valve nest in one single control valve, Cochrane Corporation introduces the Cochrane Hydromatic Single Control Valve. The valve is, in effect, a six-position valve with four normal and two standby positions. The functions of the valve, the power for which is provided by the raw water itself, are smooth, positive and free from shock, and the single lever turns with ease. The Cochrane Hydromatic Valve is standard equipment on Cochrane Zeolite Softeners and Pressure Filters, and may be arranged for manual or automatic operation.



SUMMARIZED FEATURES

1. Four normal positions—Two standby
2. Pilot-actuated for smooth shock-free operation
3. Slow motion eliminates hydraulic shock
4. Compact, built-in Rate Controllers for wash or rinse
5. Tight Seating Valve prevents leaks


Cochrane Zeolite Water Softener with Hydromatic Single Control Valve
RAW WATER INLET TO HYDROMATIC VALVE
BRASS BRINE DISTRIBUTOR
BRINE EDUCTOR
CENTRAL CONNECTION FOR WATER AND BRINE DISTRIBUTORS
RAW WATER INLET DISTRIBUTOR
METER WITH ALARM CONTACTS
TREATED WATER FROM HYDROMATIC VALVE
HYDROMATIC SINGLE CONTROL VALVE
GRAVEL OF ANTHRACITE ZEOLITE SUPPORTING
BRINE MEASURING GAUGE
SALT STORAGE FOR 5 TO 8 REGENERATIONS
SAND & GRAVEL OF GRADED ANTHRACITE BRINE FILTER
COCHRANE
Zeolite Systems & Pressure Filters
Featuring the
HYDROMATIC SINGLE CONTROL VALVE

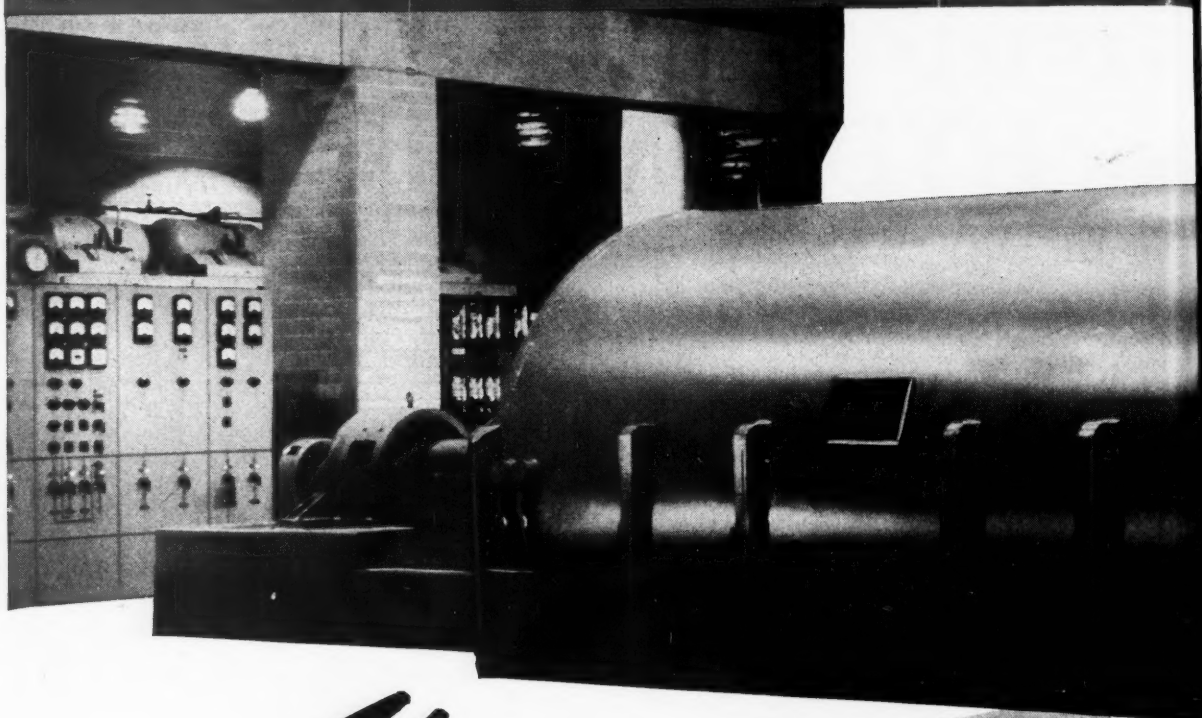
The story of Cochrane Hydromatic Valves is told in publication No. 4460 which has just been published. A copy will be sent on request. Coupon is for your convenience.

COCHRANE

Cochrane Corporation
3123 N. 17th St., Philadelphia 32, Pa.
Please send us a copy of Publication 4460 describing Cochrane Hydromatic Valve.

Name_____ Title_____
Firm_____
Address_____
City_____ Zone____ State_____

TURBINES MUST



...Use

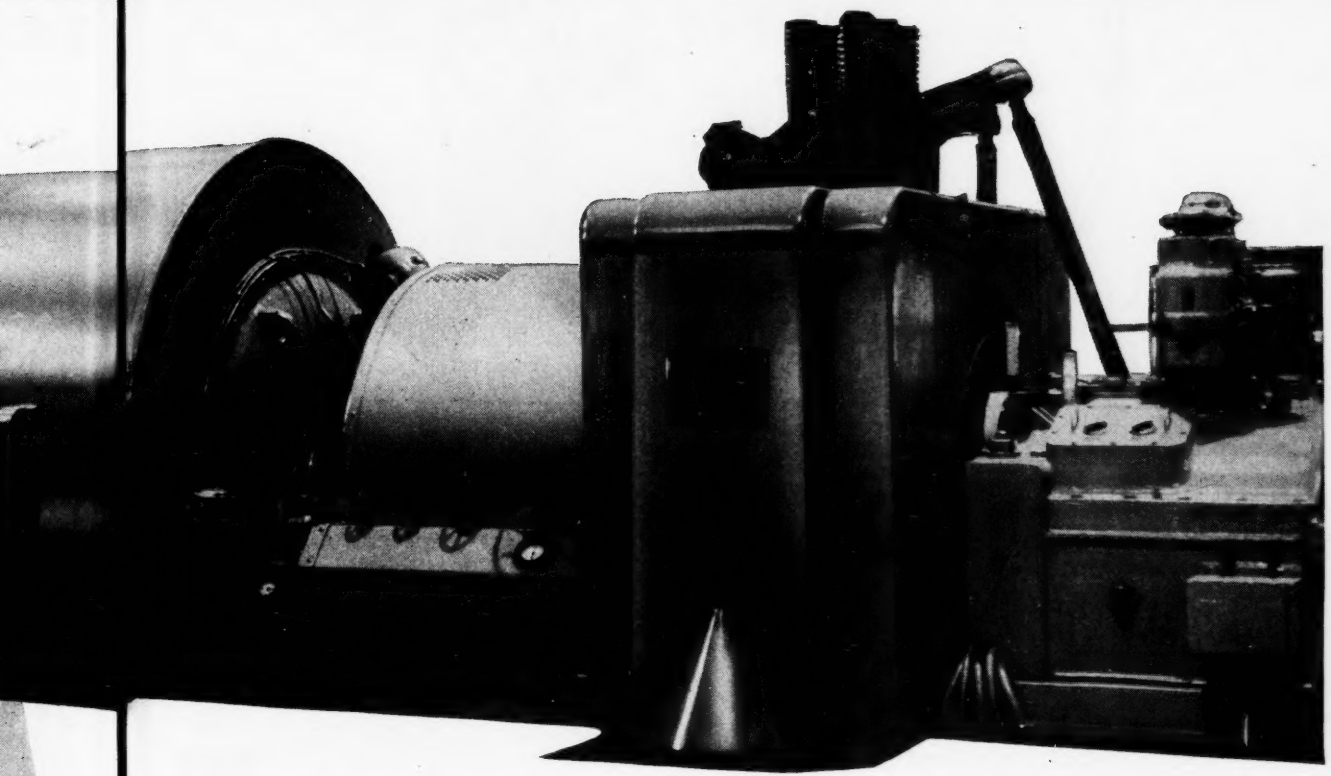
SINTURLITE OIL

Time out needed for cleaning or changing turbine oil is greatly reduced when Sinclair SINTURLITE is the lubricant. With SINTURLITE OIL on the job the circulating oil flows freely...continuously...keeps new oil qualities and delivers full lubricating value year in and year out.

SINCLAIR

YOUR NEAREST SINCLAIR AGENT WILL GLADLY ARRANGE

T BE KEPT GOING



Sinclair SINTURLITE OILS have set an enviable performance record for standing up in the grueling day in and day out grind of continuous turbine service. SINTURLITE'S inherent high oxidation stability is strengthened by proven additives. Sludge formation and acid value are checked. Protection against rust trouble is assured because SINTURLITE OILS are rust inhibited. All the lubricating requirements prescribed by the turbine builders are provided by SINTURLITE—with margins to spare. Try SINTURLITE in your turbines.

INDUSTRIAL OILS

FOR LUBRICATION COUNSEL, OR YOU MAY WRITE TO SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

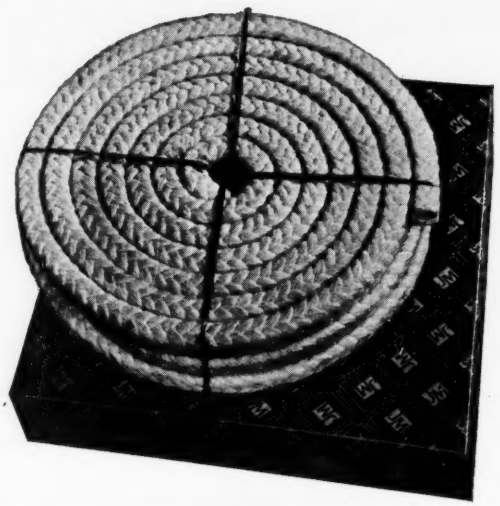
NAVALON lasts longer because it contains more lubricant and retains more lubricant

Navalon is important news to you . . . because it is a superior new packing for cold liquid service . . . another development of the J-M Research Laboratory.

Navalon—made of ramie, the strongest of all natural fibers—outlasts other packings because it *contains* more lubricant to begin with . . . and because it *retains* more lubricant in service.

Navalon is abrasive-free and rot-resistant . . . delivers outstanding performance on pumps, elevators, accumulators, presses, and reciprocating rods and plungers . . . operating against fresh or salt water, brine, cold oil and other liquids.

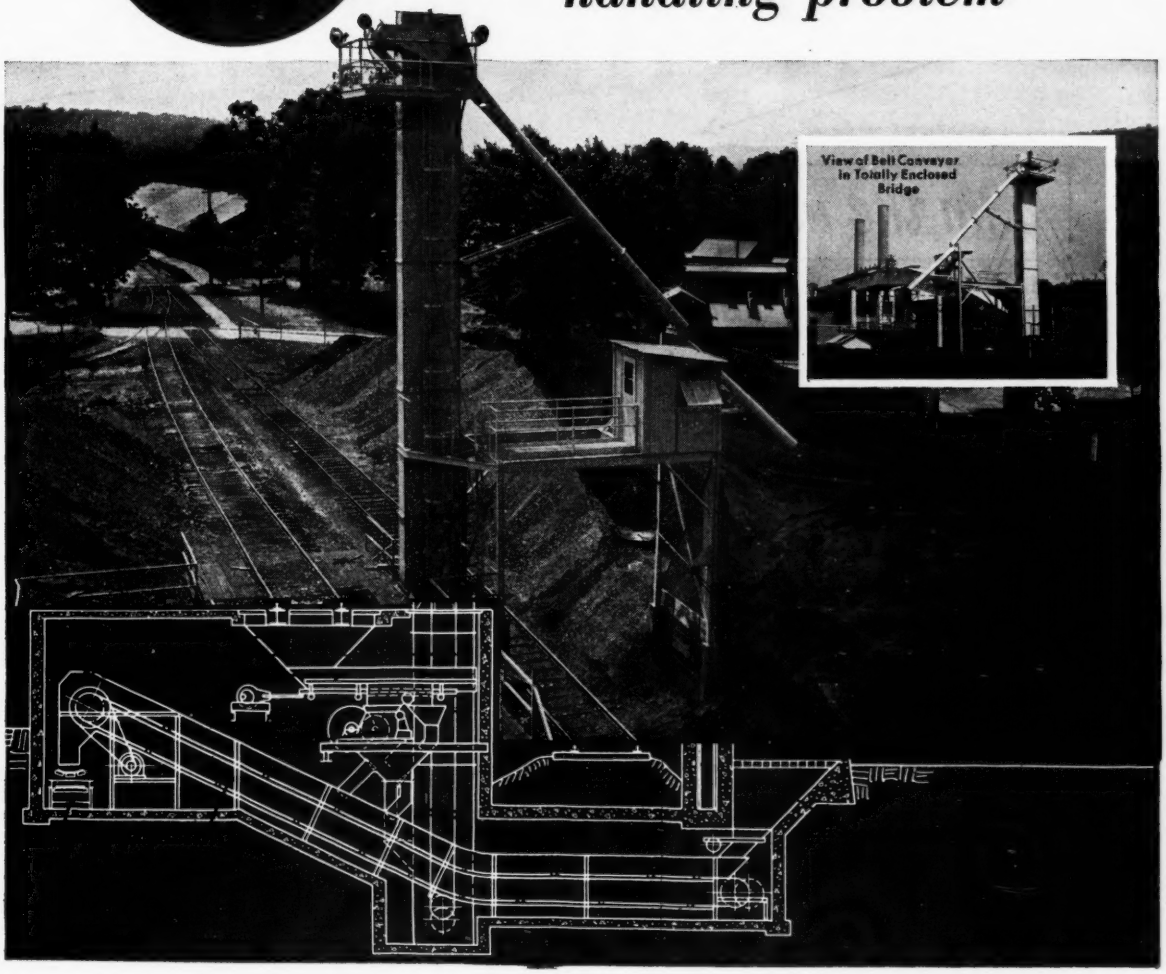
Navalon, the new ramie packing for cold liquid service, is another example of the continuing research at J-M that brings you better, longer-wearing packings for every service condition. See your Distributor—or write Johns-Manville, Box 290, New York 16, N. Y.



JOHNS-MANVILLE JM PRODUCTS

Johns-Manville **PACKINGS & GASKETS**

went *Underground* to *Overcome* this handling problem



More steam power for peak production at the Picatinny Arsenal, Dover, N. J., called for more coal—more in reserve, more flexible equipment for handling it.

Problem was how best to augment existing facilities to meet this greater demand. A Gifford-Wood engineer looked over the ground—recommended the versatile handling system shown. It provides tremendous reserve storage in addition to bunker storage.

Note how new G-W system can take coal directly from track hopper—(1) through crusher to apron feeder, then by belt conveyor to boiler house bunker, or—(2) by bucket elevator and swivel chute to ground storage. Coal is reclaimed by drag scraper from ground storage and conveyed to bunker by use of the *same* system.

But this is only one of scores of instances where G-W took over the complete job—design, construction and erection . . . shouldered all responsibility. For G-W materials handling experience dates back 140 years . . . definite assurance that consultation with a Gifford-Wood engineer can help *you* solve *your* coal handling problems.

G-W HANDLES IT . . .
faster • easier • cheaper

SINCE 1814

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Factory:
Hudson, N. Y.

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565 W. WASHINGTON ST.

FOR MAXIMUM

...in the use of fuels

the Hagan Differential Master System of Automatic Combustion Control

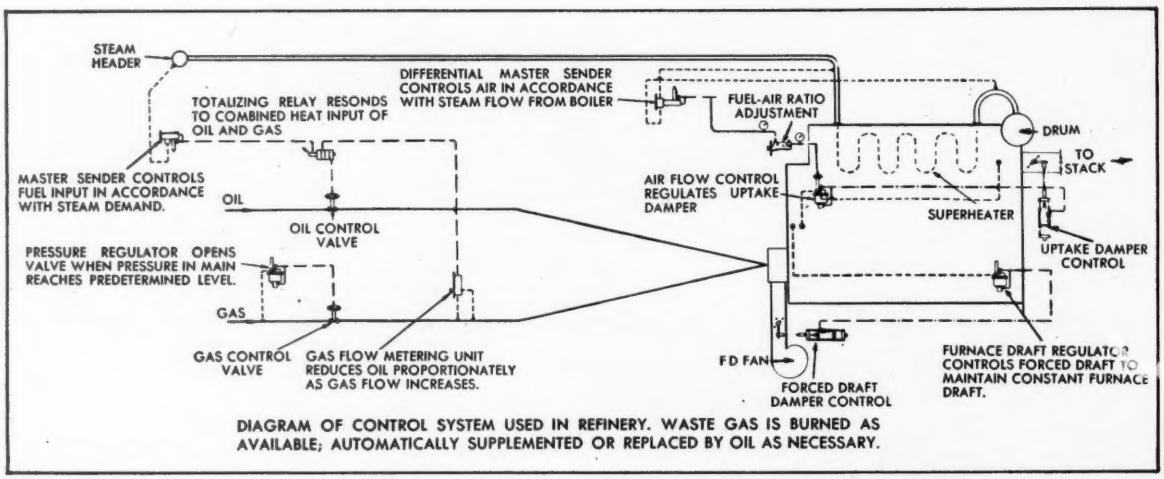

STEAM HEADER
DIFFERENTIAL MASTER SENDER CONTROLS AIR IN ACCORDANCE WITH STEAM FLOW FROM BOILER
TOTALIZING RELAY RESONDS TO COMBINED HEAT INPUT OF OIL AND GAS
FUEL-AIR RATIO ADJUSTMENT
DRUM
TO STACK
MASTER SENDER CONTROLS FUEL INPUT IN ACCORDANCE WITH STEAM DEMAND.
OIL
AIR FLOW CONTROL REGULATES UPTAKE DAMPER
SUPERHEATER
OIL CONTROL VALVE
PRESSURE REGULATOR OPENS VALVE WHEN PRESSURE IN MAIN REACHES PREDETERMINED LEVEL.
UPTAKE DAMPER CONTROL
GAS
GAS CONTROL VALVE
GAS FLOW METERING UNIT REDUCES OIL PROPORTIONATELY AS GAS FLOW INCREASES.
F.D FAN
FURNACE DRAFT REGULATOR CONTROLS FORCED DRAFT TO MAINTAIN CONSTANT FURNACE DRAFT.
FORCED DRAFT DAMPER CONTROL

DIAGRAM OF CONTROL SYSTEM USED IN REFINERY. WASTE GAS IS BURNED AS AVAILABLE; AUTOMATICALLY SUPPLEMENTED OR REPLACED BY OIL AS NECESSARY.

The key to maximum flexibility in the use of fuels is the Hagan Differential Master system of automatic combustion control.

With this system, excess air is correctly and automatically controlled at all times. You can burn gas, oil, coal or any combination of these fuels; the B.t.u. value of each may fluctuate; coal may be dry or wet, but the proper air ratio for most efficient operation is maintained.

This is accomplished simply and directly. A *Master Sender*, sensitive to steam header pressure, controls the rate of fuel feed so that B.t.u. input is in accordance with demand. A *Differential Master Sender*, measuring steam flow, regulates air flow.

Each of these units has its own function, and performs that function *directly*.

The rate of fuel feed is changed instantly to compensate for any change in steam demand, for any fluctuation in calorific value of fuel, or for any variation in feeder characteristic.

Air, however, is changed *only when there is an actual change in heat* input to the furnace, as shown by a change in steam flow.

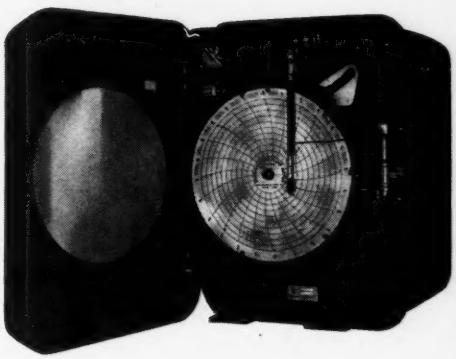
The Hagan Differential Master system will help you meet changing fuel situations in the future—and right now it will give you better control of combustion and substantial fuel savings.

flexibility

...in metering

Hagan Ring Balance Flow Meters

These meters will measure gas, air, water, steam and other fluids—and the differential head capacity for a given meter is exactly the same in any of these services. Readjustment for any differential head between 20 and 140 inches water column is merely a matter of adjusting the range screw. Ring assemblies may be changed to provide differentials outside this range—and this change can be made readily without removing the meter case from its mounting.



Our engineers will be glad to give full information on Hagan Combustion Control Systems or Hagan Ring Balance Flow Meters.

HAGAN
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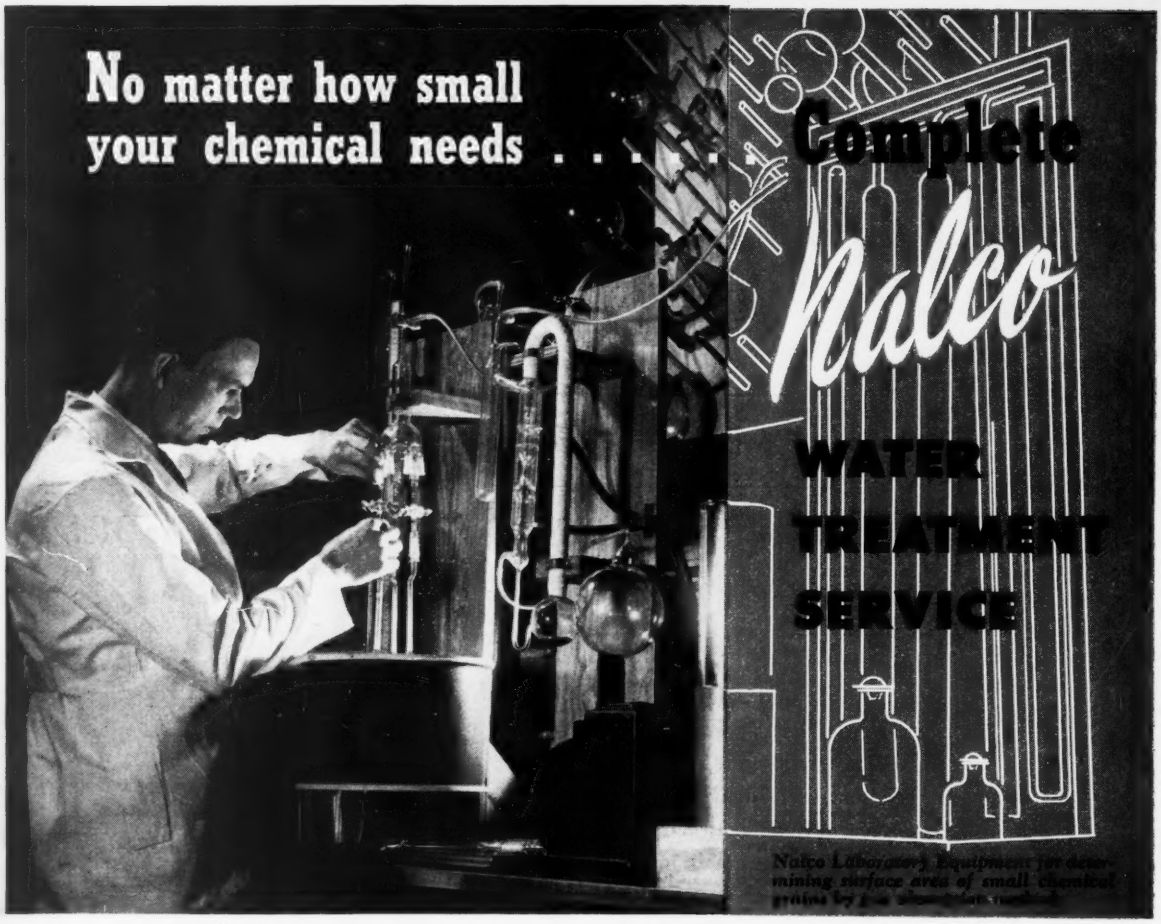
HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES



Nalco Laboratory Equipment for determining surface area of small chemical grains by [illegible]

ONE or more of these conditions usually cut chemical needs for water treatment:

- √ Evaporated feedwater
- √ Low make-up
- √ Low steam requirements
- √ Soft raw water

Filling the large demand for expert water treatment analysis and advice on control and testing procedures in plants where these conditions exist, the Nalco Service Agreement gives you:

- A complete plant water treatment survey; with detailed reports and recommendations on *your* water treatment problems.
- Supervision of control and testing procedures to assure continued water treatment efficiency; and to minimize possible shutdowns due to water treatment troubles.
- Regular Nalco Service calls to check results; and Nalco Laboratories' analysis reports to detect and correct for changes in raw water characteristics or altered plant operating conditions.

To get a prompt start toward the security from water treatment difficulties a Nalco Service Agreement provides, call your Nalco representative today, or write direct.

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. . . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

BOILERS, STOKERS, ACCESSORIES

1 **Scotch Boilers**—Bulletin No. 8-B, 4 pp., describes and illustrates with cross-sectional drawings, dimensional drawings, and tables of ratings and dimensions scotch marine type boilers. Brownell Co.

2 **Heat Insulation Reference Data**—Form 4479 SUP, 24 pp., presents data and prices on the heat insulating materials of this firm. This deals with amounts necessary for various applications and types to use. Philip Carey Mfg. Co.

3 **Boiler Return System**—Bulletin NJ 8, is a two page sheet explaining this no-vent boiler return system. Sketch gives piping hook-up. David Stout & Sons.

4 **Boiler Feed Control**—Bulletin No. 481, 8 pp., describes and depicts with sectional drawings, close-up application photos, and significant data, the use of firm's equipment for boiler feed control at one plant. Northern Equipment Co.

ELECTRICAL

5 **Coordinated Substations**—This 86-page, coil-bound data book, 9 by 12 in., illustrates and describes arrangements of substation circuits from the simplest to the most involved. These substations have been divided into three main groups—those with single feeder, two feeder substations, and three-or-more-feeder substations. Two complete pages are devoted to each arrangement covered. Scale models have been used for the photographs of the arrangements and these occupy one page; the facing page gives a complete description of the arrangement, a table of standard ratings and a wiring diagram. Westinghouse Electric Corp.

6 **Unit Substations Planning, Engineering Guidebook**—A 20-page planning and engineering guidebook 11B6895, prepared to simplify and speed the layout of load center unit substations has been announced. Dimensional and arrangement information enables industrial unit substation users to determine floor space and headroom requirements as soon as the unit is specified. Complete worked-out examples of unit substation planning are incorporated in the book. Installation procedure and pothead information are two other sections of the guidebook. Allis-Chalmers Mfg. Co.

7 **Secondary Network Systems**—There are 28 pages in Bulletin B-4002 which, in four-color illustrations, describes and gives engineering information about the use of a-c secondary network systems. The book is divided into several sections such as Network Protectors, Network Transformers, Secondary Grid, etc. Westinghouse Electric Corp.

8 **Power Line Equipment**—Bulletin 99, 36 pp., describes and depicts the wide line of power line equipment offered. Provided are tables of ratings, capacities, dimensions, and dimensional drawings. These include; fuse-switches, disconnecting switches, fuse links, wire connectors, service entrance connectors, guy cable anchors. W. N. Matthews Corp.

9 **Power House Auxiliary Motors**—Bulletin 05B 6107A, 28 pp., describes and illustrates these motors of 1 hp or more for driving power house auxiliary equipment. Photos of applications, tables for selection of types, photos of various motors, cross-sectional views and disassembly photos illustrate text. Allis-Chalmers Mfg. Co.

10 **Engineering Data on Bus Duct**—Bulletin No. 101, 32 pp., utilizes many photos, drawings, dimensional tables, capacity tables, bus temperature rise table, voltage loss tables, drawings showing how to make service head connections, and some typical applications to show uses of bus duct. Frank Adam Electric Co.

11 **Twin Rail Motor Mounting Base**—Catalog TR-801, 4 pp., describes the application of these motor mount rails for various applications. Drawings, photos, and close-up details illustrate use. Korfund Co., Inc.

12 **Electrical Tapes**—Bulletin E-BC 581, 24 pp., contains 86 photos of electrical tape applications, describes the tapes, and discusses electrolytic corrosion. Properties are listed and dielectric strength discussed. Tape is claimed to equal both rubber and friction tape. Minnesota Mining & Mfg. Co.

13 **Power Line Connectors**—This 126 pp., complete catalog consists of 5 separate catalogs and a price list of the firm's complete line of products. Equipment covered is connectors, straightline splices, deadends, splicing sleeves, cable specialties, and other items. Catalog is tab-indexed. Reliable Electric Co.

14 **Electric Motor Brushes**—Catalog Section B-2106, 24 pp., describes what brush standardization can accomplish in the way of reducing cost of brush maintenance. Also emphasized is the practical side of having stock on hand. National Carbon Co., Inc.

15 **Heavy Duty Synchronous Motors**—Bulletin 1200-PRD-175, 4 pp., contains discussion and illustrates a construction and application of these motors for drives up to 5000 hp. Cutaway sections, phantom views, drawings depict important features. Electric Machinery Mfg. Co.

16 **Electric Cable Connector Selector**—Bulletin 48Q3, 4 pp., illustrates and lists the types of cable connectors and uses they are recommended for. Burndy Engineering Co., Inc.

17 **Double Pole Double Throw Switch**—Data Sheet No. 47A contains tables of characteristics, ratings and contact life, for both ac and dc. Explanation of operation and dimensional drawings also provided. Micro Switch.

18 **Special Electric Lamps**—This 9 pp., bulletin is the general price list of carbon lamps, infra-red lamps, infra-red lamps in strips, portable units, and darkroom lamps. North American Electric Lamp Co.

19 **Self-Adhesive Lead Markers**—This 4 pp., bulletin describes and depicts the markers for applying on motors to show the proper method of connecting leads for each type of motor. Labels are claimed to be heat-resistant. W. H. Brady Co.

20 **Magnetic Starters**—Bulletin 4110, 8 pp., describes and illustrates a c magnetic starters of the across the line, non-reversing type. Complete information is given concerning application size, construction and enclosure dimensions. Ward Leonard Electric Co.

MECHANICAL POWER TRANSMISSION

21 **V-Belt Pulleys**—Bulletin FHP Buffalo, 12 pp., describes and depicts construction of these pulleys with sectional views, cutaway views, dimensional drawings and tables, and hp ratings. Worthington Pump & Machinery Corp.

22 **Flexible Couplings**—Catalog No. 48, 8 pp., describes and depicts with photos, phantom views, and dimensional drawings the flexible couplings the firm makes. Also describes combination backstop and coupling. D. O. James Gear Mfg. Co.

23 **Pulleys**—Bulletin ID-108, 12 pp., is the catalog for the pulleys listed. Sizes, dimensions, applications prices, are given. These include: iron pulleys, split or solid, pulley lagging, bronze bushings. steel conveyor pulleys, wing type conveyor pulleys; and sheaves. Industrial Div., Continental Gin Co.

24 **Variable Speed Transmissions**—This 6 pp., bulletin describes the operation, construction, and applications for which this variable speed transmission with infinite speed range is suitable. Speed Control Corp.

25 **Motor Speed Reducer**—Bulletin 3101, 4 pp., describes and pictures the new line of motor reducers and the types in which they are available. Falk Corp.

PUMPS

26 **Air Driven Chemical Pumps**—Bulletin No. 488, 4 pp., describes and illustrates with sketches of hook-ups, sectional views of pump, and a capacity-pressure selection table, these controlled volume chemical pumps driven with rotary air or gas motors. Milton Roy Co.

27 **Single Stage Pumps**—Catalog E No. A1147, 20 pp., describes and depicts the single stage, double suction centrifugal pumps intended for heavy duty work. Typical performance charts, cross-section sketches, dimensional drawings and tables and six pages of selection tables are provided. Economy Pumps, Inc.

28 **Sump Pump**—Bulletin 3100, 4 pp., gives typical speccifications and dimensions. Illustrated with sectional drawings, application sketch. Head-capacity table is given. Yeomans Brothers Co.

MATERIALS HANDLING

29 **Handling and Processing Equipment**—Catalog 791, 32 pp., describes and illustrates with application and equipment photos, arrangement sketches, sectional views, most of the equipment made by firm for materials handling and processing. Jeffrey Mfg. Co.

November, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph number:

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Please Print Clearly

Your Name.....

Your Title.....

Your Company Name.....

Company Address.....

City..... State.....

(If you prefer delivery at your home also fill in below)

Home Address.....

City..... State.....

30 **Conveyor Belt Fasteners** — This four page bulletin describes, depicts, and gives prices of the fasteners to be used on conveyor belts. Application shown with step-by-step photo series. Armstrong-Bray & Co.

31 **Flexible Hose**—Bulletin SS-100, 4 pp., describes this flexible hose made of stainless steel. The various types in which it is offered are given. Connecting flanges and male and female fittings are shown. Dimensions and data are given. Finn & Co.

32 **Mobile Bucket Loaders**—A 4 pp., bulletin describing the models K-5 and K-5B loaders. Application photos, dimensional drawings, and specifications table give essential data. N. P. Nelson Iron Works, Inc.

33 **Diesel Crawler Tractor**—Bulletin A-34-LL, 24 pp., describes and illustrates in color the applications for which this huge tractor is suitable. Information as to speeds, starting, steering, construction details is given. Full specifications presented. International Harvester Co.

INSTRUMENTS, CONTROLS

34 **Steam Engine Governors**—This 8 pp., booklet describes and contains a price list of the governors for steam engines which were formerly made by Gardner-Denver. Maker states governors are for engines smaller than Corliss. Wiebmer Machine Shop.

35 **Combustion Control Device**—Form No. A-801, 20 pp., explains the instrument offered for checking combustion control. Application photos, combustion efficiency charts, wiring diagram of instrument and the diesel engine set are shown. Cities Service Oil Co.

36 **Treatment Control Equipment**—Bulletin No. 1200, 28 pp., is replete with photos, flow diagrams, and hook-up sketches showing the many methods of applying the chemical feeder controls and equipment. Proportioneers, Inc.

37 **Rotameters**—Bulletin 18-RA, 4 pp., pictures and briefly describes the various types of rotameters and flow indicators with a capacity table for sizes. Schutte and Koerting Co.

38 **Pressure, Temperature, and Flow Controls**—Catalog 52D, 54 pp., is the complete catalog and price list of the many controls offered. Photos, capacity tables, installation and maintenance data, charts, and drawings explain and highlight the controls. General Controls.

39 **Thermal Conductivity Units**—Bulletin 848, 4 pp., describes and illustrates with hook-up sketches, specification table, and photos, these units. Gow-Mac Instrument Co.

40 **Analytical Instruments** — Catalog CEC-1300A, 16 pp., describes and illustrates briefly all the instruments designed for analytical purposes made by this firm. These are all electronic instruments. Specifications for each are given. Consolidated Enginering Corp.

TOOLS

41 **Die-Less Duplicating** — Catalog No. 48-14, 40 pp., describes and illustrates the equipment for die-less duplicating. These include such items as benders, shears, notchers, punch, brake, and the engineering service offered. O'Neil-Irwin Mfg. Co.

42 **Vise Holders**—Bulletin P-601, 8 pp., is the catalog on these vise holders and contains full specifications, and prices. Also described are the many attachments for use on special work. Holder features floating ball positioner and work holder. Wilton Tool Mfg. Co.

43 **Pipe Bender**—This catalog sheet describes the light weight portable pipe bender. Parts and application to job are depicted. Parts schedule and price list is given. Electric Cord Co.

44 **Condenser Tube Cleaner** — This 4 page folder describes and illustrates a plug used for cleaning slime and scale deposits on the inside of condenser and heat exchanger tubes. Condenser Service and Engineering Co.

45 **Metallizing Equipment**—Catalog 401, 8 pp., is the complete catalog of all the equipment offered by this firm for metallizing installations. Each piece of equipment is described briefly and shown. Shipping weights are given. This includes dust collectors. Metallizing Engineering Co., Inc.

46 **Power Tools for Standard Drills**—A six page fold-out sheet describes and illustrates pneumatic tools. Five sizes are provided. Specification table provided. Keller Tool Co.

47 **Care of Blast Gun**—This 6 pp., folder contains detailed instructions on the care and use of the combination blast gun for use in solvent or abrasive cleaning. Engineered Products, Inc.

VALVES

48 **Back Pressure Valve** — Bulletin No. 644DM8, 4 pp., describes and illustrates with flow diagrams, cutaway sections, and performance charts the characteristics of the valve. Application and style information is given. Klipfel Mfg. Co.

49 **Check Valves**—Bulletin No. 610-B describes the operation and performance of these check valves which are of the expansible tube type for air, gas, oil, or water, not exceeding 150 F. Grove Regulator Co.

50 **Bronze Valves**—This 80 pp., indexed catalog lists the bronze iron body valves of globe, angle, gate, types some with renewable seats, taper seats, rising or non-rising stem. Also accessories for opening and closing larger valves. Swing check valves. Templates for flanges, data on taps, drains. Stockham Pipe Fittings Co.

51 **Renewable Seat and Disc Valves**—Circular No. 577, 12 pp., describes and illustrates with cutaway views 3 valves in which the seat and disc can be replaced. All are of 200 lb SP class. These are globe and plug type valves. Lukenheimer Co.

HEAT TRANSFER

52 **Cast Radiation Elements** — Bulletin 40, 8 pp., describes and illustrates the integrally-cast directional finned radiation element of aluminum. Many photos and drawings show how the elements are combined to make up unit heaters and compressor inter-coolers. Wilson Engineering Corp.

53 **Heat Transfer Products**—This general catalog of 20 pages, in color, covers the entire scope of this firm's work. These cover automotive type condensers, convectors, unit heaters, air conditioning equipment, heat exchangers, large cooling units, gas condensers, and special similar products. Catalog No. 148. Young Radiator Co.

54 **Compressed Air Aftercooler**—This 4 page bulletin describes and illustrates with sectional drawings the aftercooler for air compressor systems. Specifications are presented according to size. Jas. A. Murphy & Co.

55 **Unit Gas Heater**—This heater is described in a two page catalog sheet with sketches of important parts, and dimensional table and drawing. Palmer Mfg. Corp.

PROPERTY MAINTENANCE

56 **Protective Coating for Concrete**—Bulletin B29, 8 pp., is replete with application photos of structures, such as; concrete stacks, brick, concrete, and stucco buildings, and concrete silos, which have been covered with this coating. Arco Co.

57 **Gratings**—Bulletin 20-1, 20 pp., describes and depicts with many application photos the use of the different types of gratings available. Dimensional drawings show various types of webbing. Tables give weights, safe loads, of floor and step gratings. Irving Subway Grating Co., Inc.

58 **Anti-Corrosion Coating**—Bulletin Z-CGB, 8 pp., describes the coating that is said to withstand solvent vapors, acids, alkali, salt water and chemical fumes. Photos of the type of corrosion it protects against are provided. Adhesives and Coatings Div., Minnesota Mining and Mfg. Co.

59 **Penetrating Masonry Color Coating**—Bulletin 30M-J, 4 pp., describes and illustrates some typical applications of this coating. Available colors stated. Guarantee explained. Flexrock Co.

60 **Leak Stopper**—Form AAP-348, 6 pp., describes briefly the applications for which this sealing material for concrete and other masonry work is suitable. Stonhard Co.

61 **Aluminum Roof Coating**—This four page folder explains the aluminum roof coating made by this firm. The claimed advantages are given. Liberty Chemical Products Co.

62 **Locks**—This 92 page complete catalog describes and depicts all the locks of different types for many uses made by the firm. These also include draw pull catches, friction catches, padlocks. Complete information as to size, types, weights, uses, materials, is given. Corbin Cabinet Lock Div., American Hardware Corp.

LUBRICATION

63 **Centralized Lubrication**—Bulletin of 8 pp., describes several different studies of centralized lubrication as applied to various machines, mostly presses and rolls, tipples, and sugar tandems. Farval Corp.

64 **Lubricating Film**—This 28 pp., bulletin is the service handbook on lubrication of this firm. Explained fully with photos is the series of lubricants for various applications. Lubrication survey sheet is provided. Lubriplate Div., Fiske Brothers Refining Co.

65 **Lubricator for Centralized Systems** —This 8 pp., bulletin in color utilizes cross-sectional drawings, sketches, cycle of operation chart, selection data, installation data, and illustrations of other parts for the system. Titeflex, Inc.

MISCELLANEOUS

66 **Chemical Soot Remover**—This is a 12 pp., report on the progress made by a research institute for this firm on the chemical removal of soot and slag. Drawings, and tables illustrate text. National Aluminate Corp.

67 **Nickel Alloys Publications**—List A is a listing of publications available on nickel alloys production, fabricating, properties, and uses. Back page contains address slip. Numbers desired are to be indicated and list mailed back. International Nickel Co.

68 **Bag-Type Dust Arresters**—Bulletin No. 164-2, 4 pp., describes and depicts the automatic bag-type dust arresters. Dimensions and capacities of arresters are given in drawing and table. Northern Blower Co.

69 **Double Runner Attrition Mills**—Bulletin DR-448, 8 pp., describes and pictures the use of these mills in industry. Construction details are shown with sectional views and photos. Numerous applications are shown in various industries. Sprout, Waldron & Co.

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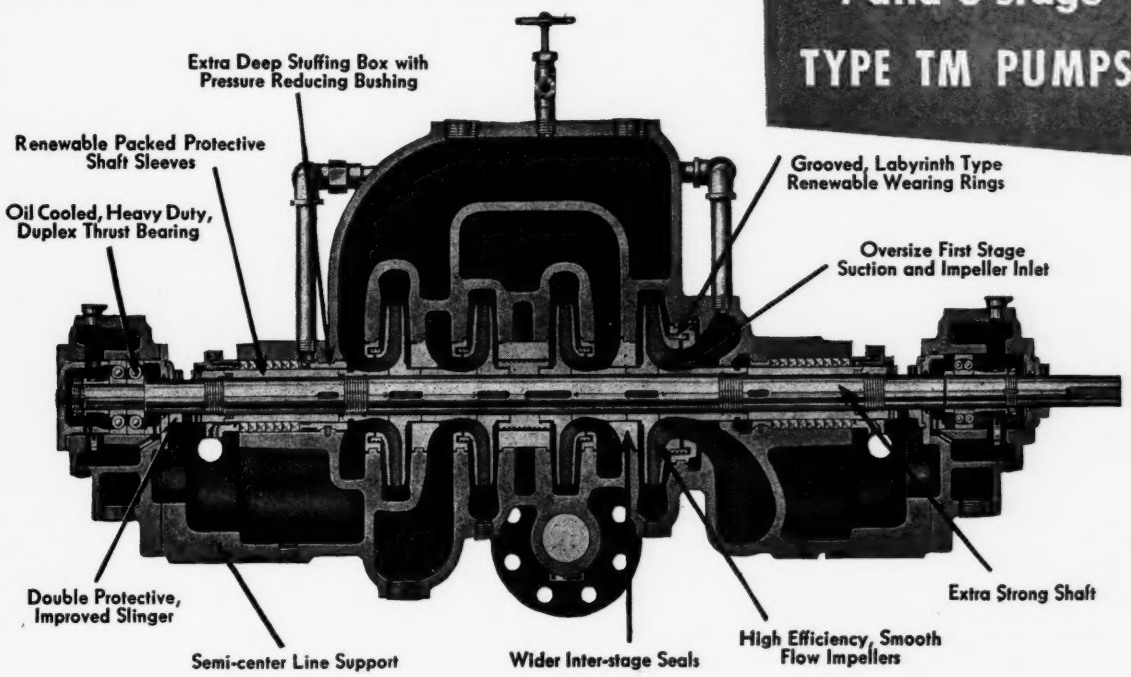
Here's why you get longer life, higher efficiency, greater dependability from

WARREN
4 and 6 stage
TYPE TM PUMPS


Extra Deep Stuffing Box with Pressure Reducing Bushing
Renewable Packed Protective Shaft Sleeves
Oil Cooled, Heavy Duty, Duplex Thrust Bearing
Grooved, Labyrinth Type Renewable Wearing Rings
Oversize First Stage Suction and Impeller Inlet
Double Protective, Improved Slinger
Semi-center Line Support
Wider Inter-stage Seals
High Efficiency, Smooth Flow Impellers
Extra Strong Shaft

Radial and Axial Balance

Increased dependability, efficiency and life result from Warren TM pumps being in radial balance as well as axial balance. Radial balance is achieved by having half the number of stages discharging up and the other half down, thus eliminating dangerous shaft deflections which cause excessive wear at all close fits, reducing efficiency. Axial thrust is controlled by mounting impellers back-to-back, thus avoiding troublesome balancing drum or thrust plate.

Lower Maintenance

Every possible care has been taken in design and construction of Warren Type TM Pump to insure utmost dependability and highest efficiency through elimination of danger of failure and reduction of wear to absolute minimum. Thus low maintenance is assured. Wherever wear is inevitable after long service, renewable parts are provided and all parts are easily accessible. Horizontally split case allows complete access to rotor, or its removal, without disturbing main connections.

Send for bulletin #241 . . . . . or better, send an outline of your pumping problem and get a Warren recommendation.

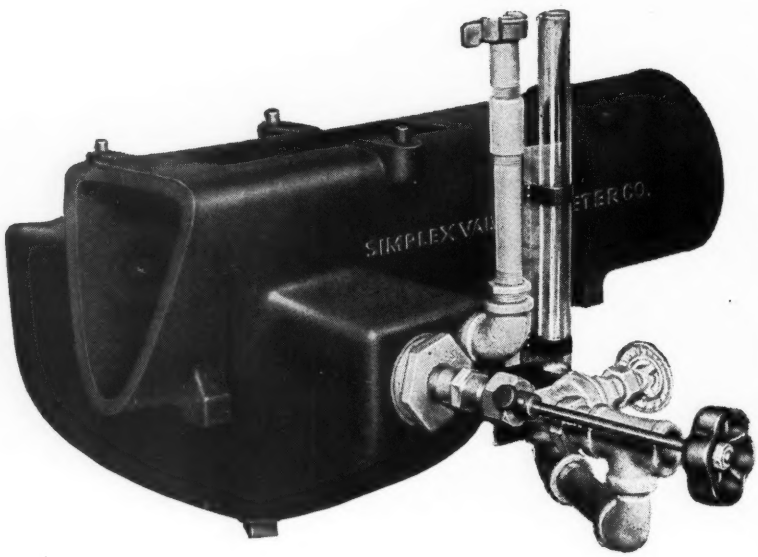
Mohawk Carpet Mills, Inc., Amsterdam, N. Y., is one of the outstanding industrial concerns where Warren Pumps are on the job. Here you see a Warren TM 4 stage pump on boiler feed service, 500 # p. s. i. delivering 500 g. p. m. Mohawk has since purchased a second Warren TM Pump.

Warren Steam Pump Company, Inc.
WARREN, MASSACHUSETTS

P-15

WARREN PUMPS

MEASURES EXTREME LOW FLOW OF WATER, SEWAGE AND INDUSTRIAL LIQUIDS



Simplex Type "S" Parabolic Flume is designed to measure accurately flows of all kinds of liquids through partially-filled pipes, sewers or channels where free-flowing conditions exist. The Simplex "S" Flume permits measurement of fluid under low head conditions and with small head loss . . . needs only slight free fall of the liquid at flume outlet. Write for bulletin and full information to the Simplex Valve & Meter Company, 6783 Upland Street, Philadelphia 42, Pa.

SIMPLEX

VALVE AND METER COMPANY

Better Coal Preparation for Greater Combustion Efficiency

WITH

AMERICAN SHREDDER RING CRUSHERS

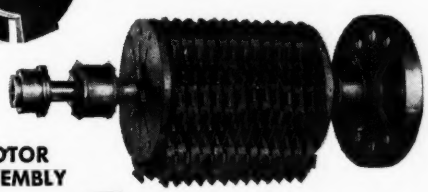
= RAGGED FIRE BED
EXCESSIVE CO_2
ASH PIT LOSS

= EVEN FIRE BED
UNIFORM COMBUSTION

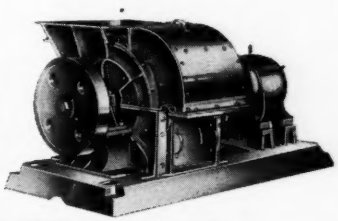
Every pound of coal means *more* BTU's—more efficient heat, when Americans do the preparation job! ROM coal is reduced rapidly with exacting control of fines, uniform sizing and no oversize—at a cost of less than 1¢ a ton. The result: Americans pave the way for a loose, uniform firebed quickly responsive to sudden steam demands—without excessive ashpit drop or unnecessary CO_2.

SHREDDER RING

Patented manganese steel shredder rings, exclusive with American Rolling Ring Crushers, *split the coal* by impact rather than by crushing. Shown below is the rotor assembly, with its many rows of shredder rings. Each ring has twenty cutting edges—and revolves on individual shaft, free to deflect from tramp iron without damage.



ROTOR ASSEMBLY



American Type "S" Rolling Ring Crusher, with heavy cast steel housing, and sectional construction, secured at dust-tight machined joints with coupling bolts for easy access to crushing chamber.

Write for details on efficiency of coal preparation in power plants with American Crushers.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

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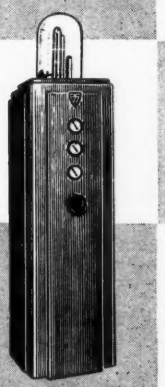
FOR YOUR HEAT EXCHANGERS OR CONDENSERS, THIS W&T CHLORINATOR CAN:



- **Reduce down time**
- **Cut operating costs**
- **Improve heat transfer**

The machine shown is a W&T Visible Vacuum Chlorinator for the application of chlorine to cooling water circuits through the W&T De-sliming process. Its design is the result of over thirty-five years of pioneering in chlorination, plus the accumulated experience of thousands of installations throughout the world.

Because of the care put into its design and construction, this chlorinator can do these things economically and dependably:

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IMPROVE HEAT TRANSFER by keeping water-side surfaces continuously protected against the formation of a slime layer.

For complete information on how these advantages can go to work for you, write today. There's no obligation.

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CHLORINE AND CHEMICAL CONTROL EQUIPMENT
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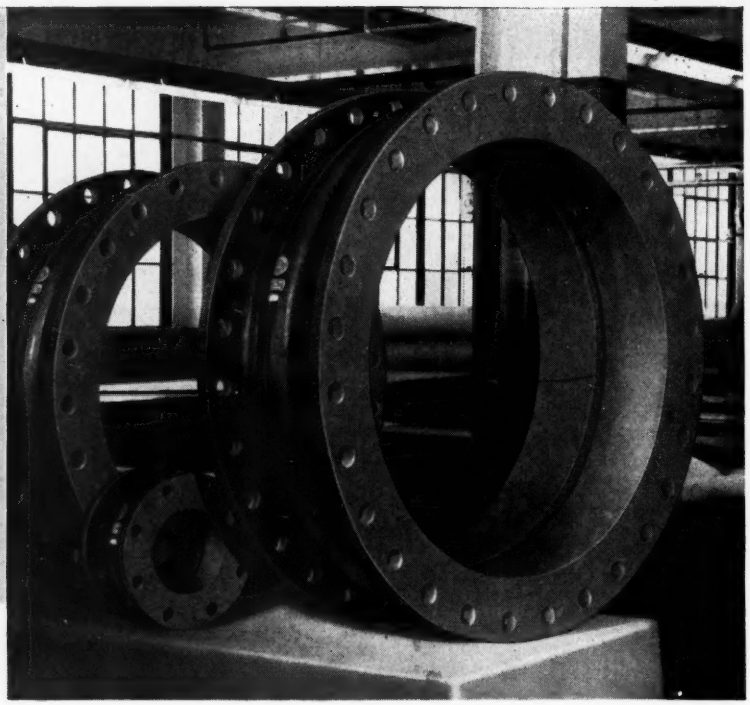
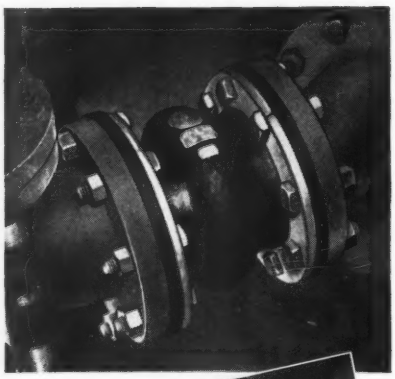
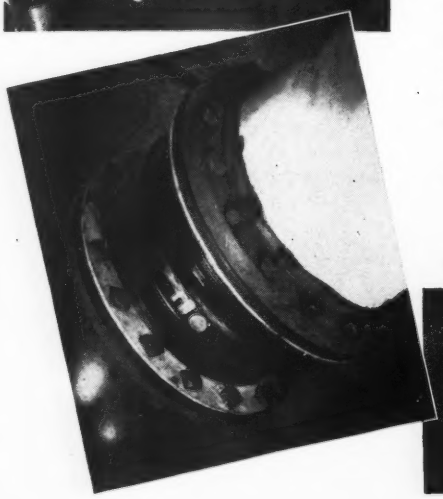
Garlock

RUBBER EXPANSION JOINTS



for Pressure, Vacuum or Pressure and Vacuum





Garlock Rubber Expansion Joints are flexible, rubber spool-type joints for installation in pipe lines to relieve stresses and strains in the piping and equipment. They function in four ways: (1) compensate for linear expansion and contraction due to temperature changes; (2) absorb vibration; (3) eliminate or reduce noise; (4) compensate for minor misalignment in the piping.

Made of an exclusive high-grade rubber compound developed in our research laboratories, Garlock Rubber Expansion Joints are strong, efficient and long-lasting. They are easy to install. Furnished in all pipe sizes from 2" to 72"—and in three styles: No. 204 for *Pressure;* No. 205 for *Vacuum;* No. 206 for *Pressure and Vacuum.*

Garlock Rubber Expansion Joints of standard construction are suitable for handling hot or cold water, brine or exhaust steam at temperatures up to 180°F. Joints with synthetic rubber lining are recommended for service involving oils, acids or mild caustic solutions. Write for new descriptive folder.

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PALMYRA, NEW YORK

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The Garlock Packing Co. of Canada Ltd., Montreal, Que.

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New Booklet

This Bird-Archer Booklet discusses the many problems involved in the use of water for power, process and cooling. It describes in detail how the Bird-Archer Water Treatment System attacks these problems and provides an elastic program for their correction. Write for your copy today on your business letterhead.

Aunt Abigail's little textile mill is powered by knee-action. She doesn't need water treatment . . . although she may need treatment for water—on the knee.

But a modern textile mill, or any plant using steam for power or water for process or cooling, depends for continued efficiency of operation on correct *and complete* water treatment.

Only that water treatment service which attacks every cause of scale, corrosion and carryover can assure minimum operating costs . . . eliminate excessive replacement of steam and water handling equipment . . . boost operating efficiency.

On that principle the Bird-Archer 8-point Service—all or any part of which is available to you—was developed. Each step in this complete water treatment system evolved out of more than 60 years of specialized experience in the water treatment field. All eight steps together constitute a program which cannot fail to locate and correct the source of your water treatment problems.

Ask to have a Bird-Archer representative call and give full details.

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Ready power for the PETROLEUM INDUSTRY with WICKES TYPE-A water tube boiler

Designed for efficient steam generation, Wickes Type-A water tube boilers are now in use in the nation's leading oil refineries. Three proved advantages make this Wickes unit *the most efficient of its type:* 1) — It has twice the black surface of the average boiler; 2) — Combustion gases travel through staggered rows of tubes, assuring high operating efficiency under varying load conditions; 3) — Two simple U-tubes with no excessive resistance, *insure positive water circulation* necessary to high heat absorption. • Wickes Type-A Water Tube Boilers are made in capacities to 200,000 lbs. steam per hour, with pressures up to 850 lbs. psi. Drums welded to A.S.M.E. standards. *Write for descriptive catalogue.*

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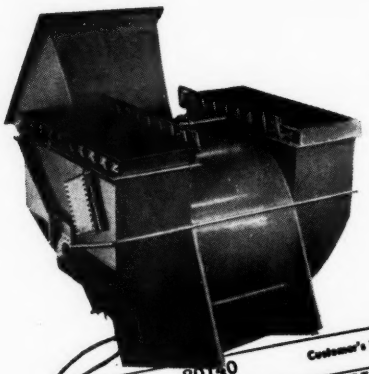

◀ **Sirocco Fans,** forward inclined blade type, are especially designed and proportioned for induced draft duty.

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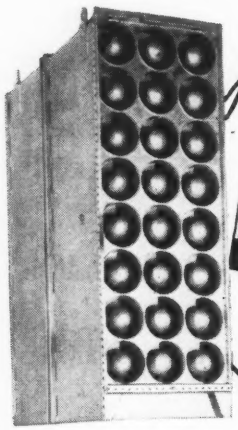

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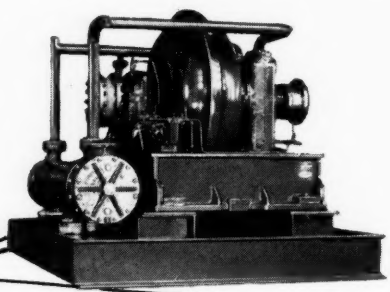
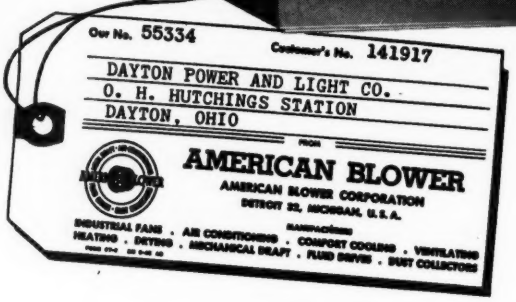
▲ **TYPE ST** Fly Ash Precipitator prolongs life of induced draft fans and alleviates air-pollution problem by collecting fly ash.

Type VS Gýrol Fluid Drive —for adjustable speed control of forced and induced draft fans. ▼

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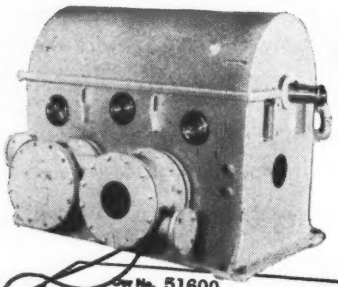

◀ **Type VS** Class 6 Gýrol Fluid Drive — for adjustable speed control of boiler feed pumps.

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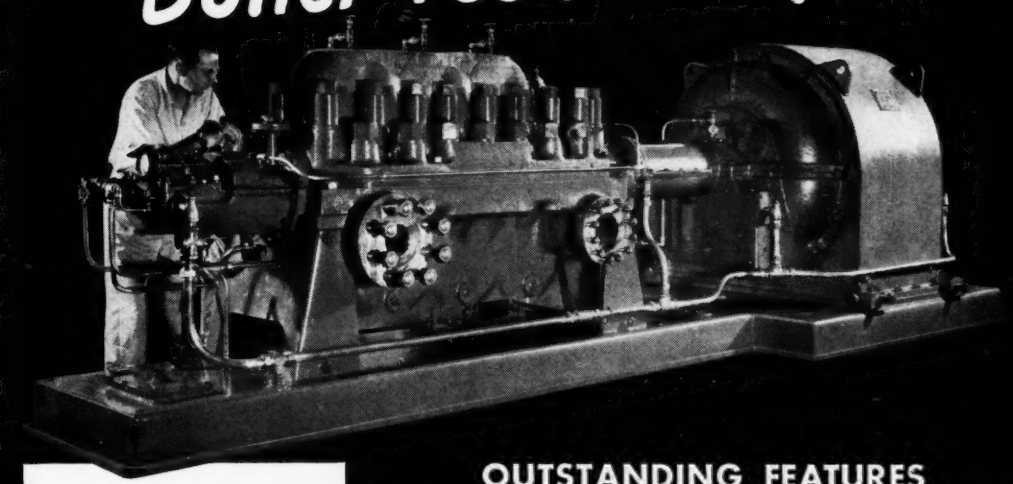
PRODUCT OF THE MONTH

DEPENDABLE

Boiler Feed Pumps



A 6 by 5 in. DL-7-stage Doubleton centrifugal boiler feed pump rated 650 gpm, 1,690 psi, 3,580 rpm pumping 283° F water and driven by a 1,000 hp Allis-Chalmers motor.

OUTSTANDING FEATURES

- **VOLUTE CASING** allows pumps to operate smoothly over a wide range of the head and capacity curve.
- **DOUBLE SUCTION IMPELLERS** allow for a lower net positive suction head (N.P.S.H.).
- **BEST MATERIALS** for specific water conditions are selected for your application — your assurance of getting maximum durability.

MILWAUKEE, WIS. — Advanced design, specialized engineering and finest materials fit Allis-Chalmers boiler feed pumps for reliable, heavy-duty powerhouse service. Added benefit: carefully matched Allis-Chalmers pump-motor "team" means you get assurance of satisfactory unit performance.

BE SURE TO GET an Allis-Chalmers quotation for your next boiler feed pump application. Allis-Chalmers is the only source of pumps *and* motors in *any* type, *any* size. Backed by 60 years of pump building — more than 50 years of service to the electric power industry.

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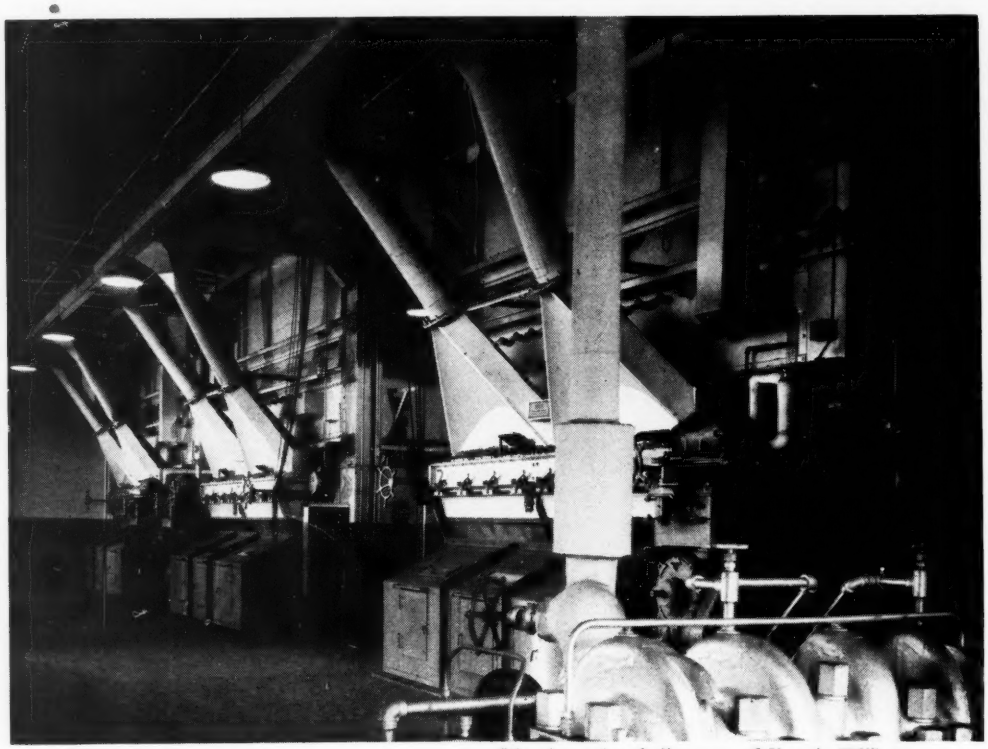

View in modern boiler room of Sherwin-Williams plant, Chicago.

75% Make-Up Water Conditioned for Maximum Efficiency with *Dearborn* Treatment and Test Control

As a sound protective measure, new boilers in a modern plant should rely on advanced water conditioning techniques for steaming efficiency. Dearborn's contribution to top performance in this plant is the installation of a program of scientific external and internal water treatment and test control designed to meet operating conditions.

The three boilers at Sherwin-Williams plant, which use approximately 75% make-up water, are operating continuously on a scale- and corrosion-free basis under an individualized Dearborn treatment program. After systematic tests carried on by the Dearborn Engineer in the boiler room, recommended treatment formulations are introduced automatically in proportion to water requirements. Systematic water test routine has been established to maintain treatment balance. This program is producing highly satisfactory results. Similar programs are producing excellent results in numerous power plants.

You are invited to investigate what Dearborn service can do for you. Call your near-by Dearborn Engineer or write direct to us.

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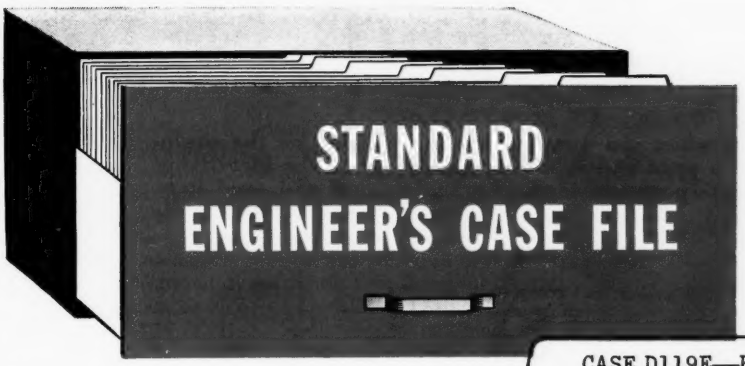
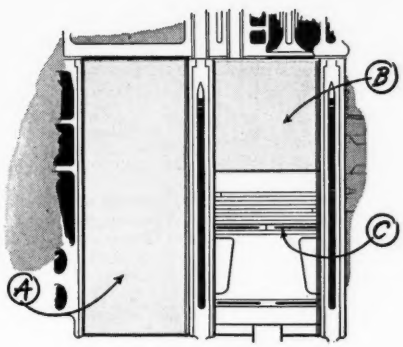
Dearborn

THE LEADER IN BOILER WATER TREATMENT



CASE D119E—REDUCING WEAR ON LINERS IN DIESEL ENGINES



DIESEL ENGINE LINERS AND PISTON

In high-speed Diesel engines lubricated with RPM DELO Diesel Engine Lubricating Oil, wear on liners was held to a minimum with little variation over their entire areas. A constant lubricating film was maintained on them even in high-temperature belts. RPM DELO Oils are recommended for all types of Diesels. Come in all viscosity grades necessary for your engines.

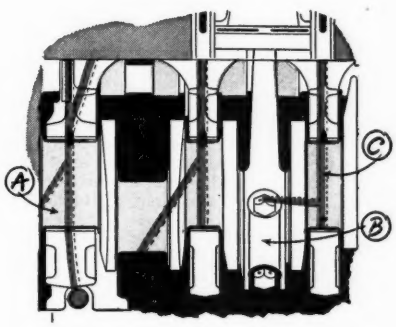
A. Special additive provides metal-adhesion qualities...keeps oil on all parts whether hot or cold, running or idle.

B. An anti-oxident resists formation of lacquer—resistance to extreme heat provides lubrication in the toughest conditions.

C. Contains detergent which keeps rings clean and operating freely...prevents scratching and gouging of liners.

RPM DELO Diesel Oil will not corrode any bearing.

CASE D119F—PROLONGING THE LIVES OF BEARINGS IN DIESELS



SECTION OF DIESEL ENGINE CRANK AND CAM

No bearing failures occurred between overhaul periods in Diesel engines used in the toughest service when they were lubricated with RPM DELO Diesel Engine Lubricating Oil.

A. Non-corrosive to all types of bearing metal...inherent ability of base stocks and added compound resist oxidation and formation of acid which is common cause of bearing corrosion.

B. Maintains a tough lubricating film which withstands excessive shocks and pressures.

C. Special detergent compound keeps oil passages clean and open - allows free flow of lubricant to vital points.

Another compound in RPM DELO Oil prevents foaming of the oil. An accurate measurement of crankcase levels can always be obtained.

For additional information and the name of your nearest Distributor, write

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DIESEL ENGINE RPM DELO LUBRICATING OIL

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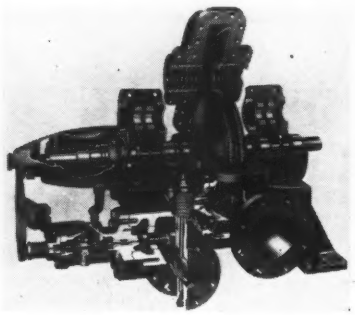
Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

A General Purpose Turbine. A new all-weather general purpose turbine for driving industrial pumps, fans, blowers, compressors, paper machinery, and small generators, the Typee, has been announced. A choice of three wheel sizes, 16, 20, and 25 in., permits Typee turbines to be applied over a range of 5 to 1500 hp with steam conditions up to 600 lb ga at 750 F, and speeds of 1000 to 7000 rpm. Equipped with heavy duty parts the turbine will operate at 1500 lb ga at 950 F. Many parts are interchangeable between wheel sizes.

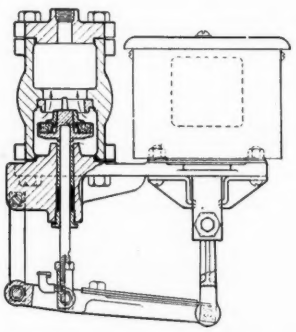
Efficient combination felt and labyrinth bearing seals protect the lubricating system from contamination so that neither torrential rain nor the presence of abrasive dust will affect its operation. Corrosion resistant materials are used liberally throughout. An overspeed trip simultaneously closes the governor valve and a heavy butterfly valve at a predetermined speed. Improved free-expansion center line support is arranged so that pipeline reaction is transmitted to the foundation. The basic turbine is equipped with a shaft type governor, mounted in a rugged casing that completely protects the governor assembly and shaft end. The entire governor assembly can be replaced without disturbing the shaft. It is interchangeable between wheel sizes. Typee turbines may be equipped with special wide speed range governors where required. Westinghouse Electric Corp.



B Plastic Case Battery. A storage battery, made with a plastic case and said to offer more starting power with less space and weight. Features transparent polystyrene plastic as the container material for the battery. The battery is rated at 24 v, and is capable of producing 15 hp for 3 min. The container permits a ratio of power to cubic content and weight greater than heretofore possible. It has connections for venting gas automatically on charge and discharge, a no-overflow device to prevent over-filling, and complete filling and operating instructions which are molded into the plastic. Electric Storage Battery Co.

C Solenoid Valve. A 150 lb globe type solenoid valve, specifically designed to meet emergency or safety requirements, has recently been announced. Intended for service in which the valve is normally open, this Series No. 6000 valve is capable of remaining closed for indefinite periods of time. When an emergency arises, the control element immediately causes the solenoid to be energized, thus closing the valve instantly. Since the valve closes with the pressure and flow, it will remain closed as long as a pressure above three pounds exists on the inlet side, and regardless of whether or not the solenoid continues to be energized.

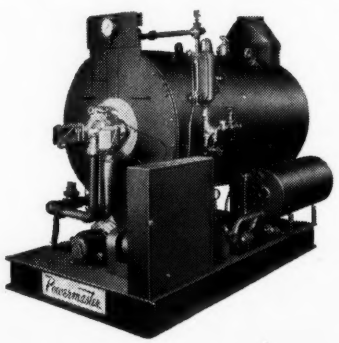
To permit easy opening of the valve once the emergency has passed, a simple piping arrangement is utilized.



A ⅛ in. pipe, branching from the main inlet pipe, by-passes the inlet side of the valve and leads directly into the chamber on the outlet side. Flow through this pipe is controlled by a ⅛ in. globe valve. Opening equalizes the pressure above and below the disc, thereby allowing the solenoid-controlled valve to open. It is necessary that there be a shut-off valve in the outlet piping if it is not dead-ended. The globe valve is then closed and is ready for the next emergency.

The series No. 6000 valve has a heavy cast body, suitable for pressures up to 150 lb, and is furnished with Jenkins disc construction to handle steam, hot or cold water, gas, air, gasoline or oil. Available in six sizes, from ¾ to 2½ in. It may be used on 110, 220, 440 v, 60 cycle, and is provided with a ⅛ in. I.P.T., opening in the cap. Johnson Corp.

D 3-Fuel Steam Generator. A new steam-generating unit which burns light oil, heavy oil, or gas is announced. All three fuels are burned with the same burner, making a change-over from one fuel to another a matter of only 10 min. or less. Usually a fuel switch from light oil to heavy oil is a major operation requiring several hours. It is believed that the unit will be efficient and economical for heating,



November, 1948

POWER GENERATION
53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

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Please Print Clearly

Your Name.....

Your Title.....

Your Company Name.....

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Everything in power piping ...on One Order to Crane

Take This Turbine Piping, for example. Every item in the system—valves, fittings, accessories and pipe—is from Crane, the world's leading supplier of industrial piping. Whether it's piping for power, process, or general service installations, there's no need to search further than the complete Crane line. Everything's in **One Catalog**—an unequalled selection of brass, iron, steel and alloy materials. **One Order** to your local Crane Branch covers all equipment needed for the job.

Complete selection and availability are not the only advantages in dealing with Crane, however. To standardize on this **One Source of Supply** is to simplify every piping procedure, from design to erection to maintenance work. **One Responsibility** for all materials helps you get better installations, avoids needless delays. And in every item from Crane, **High Quality** is your best assurance of dependable performance from every part of your piping systems.

Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
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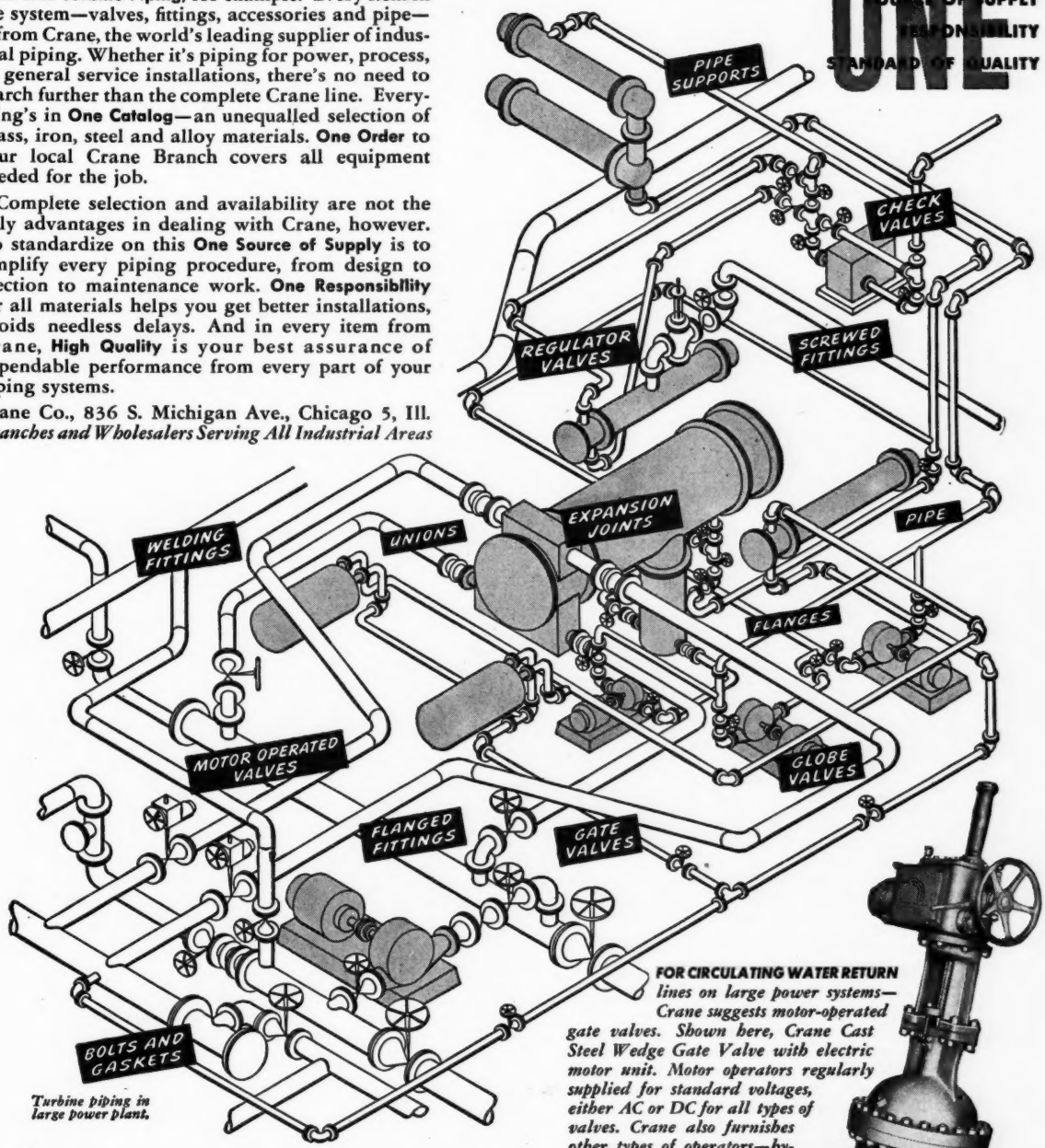


Turbine piping in large power plant.

FOR CIRCULATING WATER RETURN *lines on large power systems—Crane suggests motor-operated gate valves. Shown here, Crane Cast Steel Wedge Gate Valve with electric motor unit. Motor operators regularly supplied for standard voltages, either AC or DC for all types of valves. Crane also furnishes other types of operators—hydraulic, air, etc. See your Crane Catalog.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

process, steam or power generation in sections of the country where interruptible or off-peak gas service rates are in effect, and in any section experiencing an oil shortage.

The new Powermaster boiler system ranges from 15 to 200 hp and is fully automatic. It is claimed to burn heavy fuel with the same complete clean combustion with which it burns light oil and gas. Fully automatic operation of heavy fuel combustion is a feature of the unit. Orr & Sembower, Inc.

E **Squirrel Cage Motors.** Announced is a new line of tube-type, totally-enclosed, fan-cooled, squirrel-cage motors ranging from 150 to 600 hp. The use of tubular type heat transfers follows, in general, the methods employed in previous motors of larger size. Internally, the new motor is divided into two isolated parts with each side

having its own path of internal air circulations. Because of its construction, it is possible, through simple maintenance, to keep the motor free of power-destroying agents which tend to clog air passages in the conventional type of fan-cooled motors.

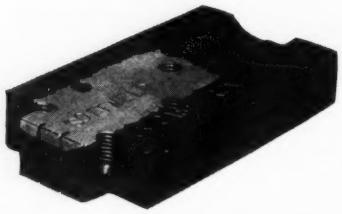
The new line is being offered with Underwriters' labels for 1-D or 2-G locations in ratings of 3600 rpm, 250 to 400 hp., 1800 rpm, 200 to 300 hp., and 1200 rpm, 150 to 200 hp. Allis-Chalmers Mfg. Co.

F **Circuit Breaker Closer.** A manually operated stored energy closing device which provides a means of closing magnetic type circuit breakers in locations where no suitable source of electric closing power is available has been developed.

This device is said to safely close the breaker under all conditions within its rating, including closing and latching against maximum rated short circuit current. Since it operates from energy stored in the mechanism by manual operation prior to the actual closing motion, the breaker is closed at the correct speed and applied force, duplicating the action of electrically operated mechanisms. These are for Magneblast breakers rated 5 and 15 kv, 100,000 to 500,000 kva inclusive. Switchgear Div., General Electric Co.

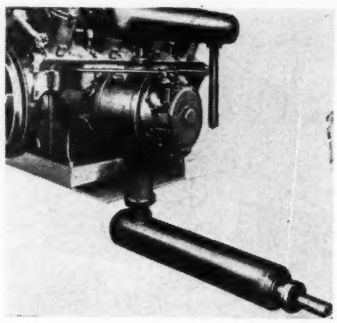
G **Depositing Electrode.** Announced is a new electrode for welding cast iron. The new electrode is called Softweld and is for depositing dense, soft machinable welds in gray iron castings. Softweld is a non-ferrous electrode and operates with a soft steady arc on either alternating or direct current.

The operating characteristics of the new Softweld bring a new ease to welding cast iron for machining. The electrode is designed to cause the weld to flow over and bond to the cast iron with a minimum of penetration and heating of the base metal. The deposit is smooth, dense and well feathered



into the base metal. The entire weld area may be drilled, machined, sawed or tapped with ease. Its operation on both straight and reverse polarity gives it a versatility in that it may be used either to build up an edge, in making such repairs as restoring broken gear teeth, or it may be used to fill in holes in defective castings. It is available in the 14 in. length in 1.8 in. and 5.32 in. sizes, packaged in 10 lb containers. Lincoln Electric Co.

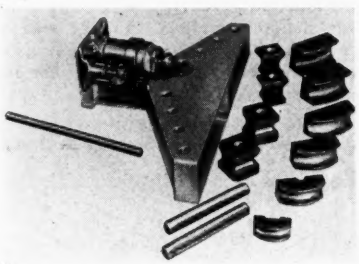
H **Pulsation Dampener.** A Fluor pulsation dampener for installation on the suction and/or discharge sides of compressors to eliminate excessive vibration caused by pulsative flow through gas, air or vapor lines, is announced. Vibration, if continued long enough, can cause metal crystallization and subsequent breakage of pipe lines resulting in death, damage to or loss of eyesight, skull fracture, broken bones



or other crippling injuries to workmen within range of the explosion. Fires, property damage and long costly shutdowns can also result from line breakage. Elimination of vibrating floors and platforms, rattling doors and windows save wear and tear on workmen's nerves resulting in increased operating efficiency. Benson & Associates, Inc.

J **Floor Color Coating.** Wherever difficult conditions must be met because of attacks upon ordinary paints by alkalis, water, acids, oils and hard wear the new Colorflex Plus A.W.A. synthetic resin penetrating color-coat will give a preservative and beautifying surface, indoors and out, to floors, walls, and ceilings, whether of masonry, cement, metal, wood or composition. Highly resistant to internal chemical action of cement when in the presence of moisture the new product will not saponify, and resists the alkali in soaps and cleaning compounds. Water will not cause surface to soften and it remains impervious to mineral oils and lubricants. Colors remain fast under exposure to light, either natural or artificial. Penetration by dust and dirt is prevented by the color-coat and surface resulting from application is easy to clean and polish. Flowed on smoothly, easily and quickly, as shown, the application can be accomplished by anyone. The even coat builds-in resistance to disintegrators and "builds-up" a durability which eliminates need for frequent repainting. Available in red, gray, green, brown and as a clear coat. Flexrock Co.

K **Pipe Bender.** This new lightweight, portable tool forms smooth, uniform pipe bending operations right on the job. Weight has been kept down to a minimum without loss of strength. The combined weight of the jack and frame is only 83 lb. Removable hydraulic jack simplifies the



service problem and can be used for other purposes. Of open jaw construction. The 30 in. steel frame is electrically welded and heavily reinforced. Comes complete with ¾, 1, 1¼, 2 and 2½ in. dies. Price, $125. Electric Cord Co.

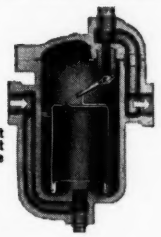
L **Rodding Machine.** The new model 600 Electro-Rod embodies a new and more powerful reversible motor with new gear train mounted on hardened and ground shafts rolling in needle bearings, new ball-thrust bearings, 3 conductor cord providing ground wire, and new off-on switch for greater safety from shock.

New patented Rota-Tilt cable con-

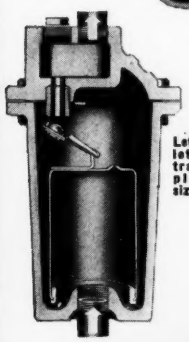
tainer has push-button controlled tilting. A touch of the finger tilts container at any desired angle to cleanout and has a capacity of 100 ft of ½ in. sewer cable. Cable is especially coiled and re-inforced with inner cable to withstand added torque of motor driven

WHY ARMSTRONG TRAP MECHANISMS *last so long!*

CHOICE OF BODY STYLES



Right: Side Inlet — Side Outlet traps for in-line installation.



Left: Bottom Inlet — Top Outlet traps in a complete range of sizes.

This Armstrong No. 213 trap on a storage type hot water heater has been in service 14 years without repairs.

WHAT USERS SAY

36 Armstrong Traps on heating system service in an Atlanta building still going strong without maintenance after 10 years.

* * *

One minor repair job in 20 years —that's the record of the Armstrong traps in service at South Dakota hospital.

* * *

Standardization on Armstrong traps slashed maintenance—first trap operating over 15 years without repairs—Canadian foundry.

SEND FOR the Armstrong Steam Trap Book—36 pages on trap selection, installation and maintenance. Free on request.

...They're built to stand 1500 psi, 1000°F

The user of standard Armstrong steam traps for medium and low pressure service reaps the benefit of the research, investment and experience that went into the development of Armstrong forged steel traps for high pressure generating station service.

The valves and seats in all Armstrong traps are chrome steel, hardened, ground and lapped to a precision fit. The inverted buckets and valve lever assemblies are all corrosion resistant 18-8 stainless, heavily reinforced for wear. In normal service these mechanisms often last for years without attention. And when a valve finally wears to the point where it fails to seat properly, it is usually good for a relapping—a job any maintenance man can do in a few minutes. Or replacement is a simple, inexpensive job.

It's this built-in quality of Armstrong traps that keeps them on the job without leaking steam, without sticking or clogging, without frequent maintenance. Quality pays dividends when it comes to steam traps. Plan now to standardize on Armstrong, the *quality* traps. Call your Armstrong representative or write:

ARMSTRONG MACHINE WORKS

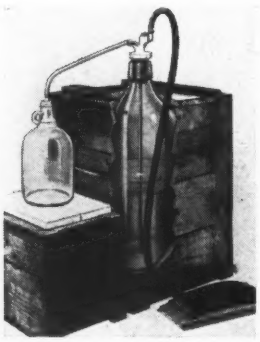
810 Maple St., Three Rivers, Michigan

ARMSTRONG — Inverted Bucket STEAM TRAP

ARMSTRONG STEAM TRAPS

machines. The motor unit is easily detachable and when removed it is an excellent slow-speed drill when used with carbide tips for drilling clean sharp holes in tile, slate, mortar, etc. When used with a carborundum cutting disc and arbor bit it is ideal for cutting and removing damaged tile from walls, floors and ceilings. Spartan Tool Co.

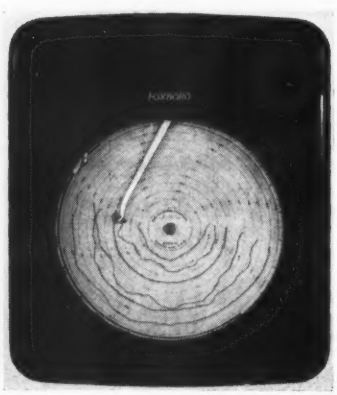
M **Acid Pump.** Safe and convenient transfer of acids and other liquids from carboys, barrels or drums is now possible with the improved foot-or hand-actuated Pneumatic Pump. Liquids flow smoothly and stop instantly. They come in contact only with the corrosion-resistant tube and cannot affect other parts. No tilting of



the container is necessary and danger of a slip, a splash or a spill is minimized. When removed, from container, liquid drains completely.

G-S Pumps with lead tubes are suitable for sulphuric, hydrochloric, hydrofluoric acids and many others. Price, $11.30 complete. Saran plastic tubes are recommended where pump is to be used in nitric, muriatic, citric, phosphoric, acetic, bleaches and others. Price, $12.80 complete. General Scientific Equipment Co.

N **Multi-Recorder.** The Multi-Record Dynalog is announced. It is a high-speed instrument, completely electronic in principle, making from one to six different records on one circular chart, the records being of colored dots so closely spaced as to make virtually continuous lines. The recorder has only one measuring system, either resistance bulb or EMF type, but a positive-acting switching unit automatically brings the vari-colored pens into recording



position at 6-second intervals, in any sequence desired. The sequence and number of points may be changed at will, quite easily. Complete color-coding prevents possible mis-mating of circuits and pens.

A conspicuous innovation in the design of the recorder is the use of its Rotacolor pen wheel holding the six recording pens, which are magnetically selected in turn and held in recording position by a single pen arm. The Multi-Record recorder may be used for measurement of temperature, pressure, humidity, liquid level, pH, conductivity, and other process variables. Foxboro Co.

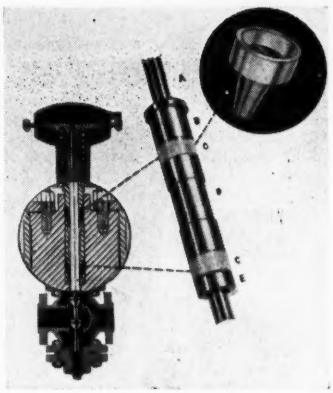
O **Grease and Applicator.** A new heavy lubricant for open gears under extreme service conditions and a new method of application, offer new and greater savings to industry. Grease No. 32, the new lubricant, is equally effective through a wide range of temperatures, retaining its plasticity, tenacity and density from sub-freezing cold to its melting point, which exceeds 400 F. It repels water, even at boiling temperature.

Packed in rigid leak-proof paper cartridges which fit in specially designed gun applicators, the grease is fed through the nozzle in a broad ribbon, which assures its reaching the

pressure side of gear teeth. This method makes for easier, cleaner, faster and more economical application, even while gears are in motion, saving both manhours and production time. Grease consumption also is reduced by the longer service life of the new lubricant. Keystone Lubricating Co.

P **Valve Stem Seal.** The Dahl-Seal is a scientifically shaped inert plastic seal. It will provide a frictionless, leak-proof valve stem on a control valve regardless of system pressure. The control valve stem is hermetically sealed by the force of the system pressure due to the special shape of the Dahl-Seal. It eliminates and replaces the conventional packing box. No take-up or adjustment is necessary as it is inherently lubricated and is completely resistant to chemical attack. It can be used for any temperature for which the valve is designed. The valve stem can be positioned to an accuracy of 0.001 in. at full vacuum, atmospheric to 25,000 psig.

The gland follower, gland and lower



gland clamp the Dahl-Seal firmly in place, the lower lip is completely unsupported and subject only to the system pressure. System pressure on this lip seals the super finished valve stem. Once adjusted at the factory, no further field adjustment is necessary. Hammel-Dahl Co.

Q **Condensation Pump.** Known as the 4100 Series Condensation Pump this new unit is said to have a wide capacity range. It is conservatively rated to handle any capacity up to 6000 sq ft EDR, or 9 gpm, against a discharge pressure up to 20 lb. All parts are claimed to be easily accessible from the front for quick inspection and servicing. Removal of only four cap screws permits the entire motor and impeller assembly to be lifted from the pump housing without disconnecting piping. The impeller is of bronze of two piece construction, and is fitted with an oversize carbon type rotary seal. The capacitor-start ¼ hp dual voltage motor is dynamically balanced for quiet operation. Condensate is collected in a heavy 15 gal steel tank. Strainer is built in. Levels are controlled with a non-corroding float set to a single pole float switch. Sterling, Inc.

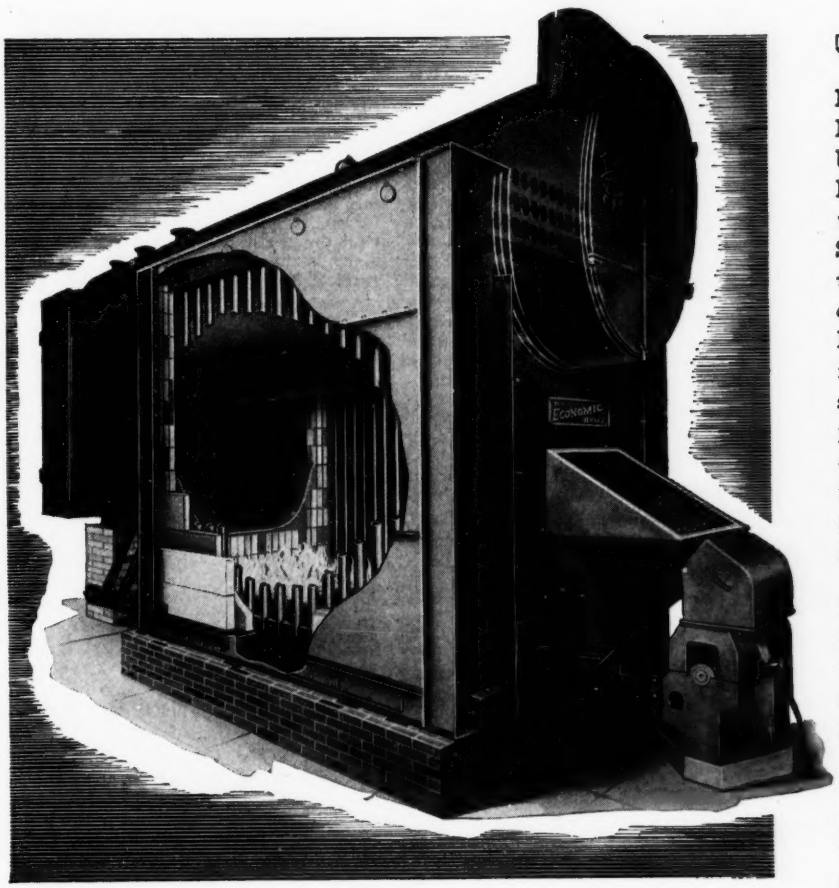
R **Impact Nut Setter.** A portable electric impact nut setter is announced. Universal, 110 v 60 cy ac or dc, and High Cycle, 220 v 180 cy 3 ph ac, models are available. The new models have capacities from ⅜ to ¾ in. bolt size.

The Speed-O-Matic tightens or removes nuts, bolts, studs and lag screws and can also be used effectively for drilling, tapping, etc. It is said to be torqueless; will not twist in operator's hand when nut becomes tightened. This means greater ease of operation and

ERIE CITY

Provides Water-Cooled-Refractory in a Self-Contained Fire Tube Boiler

SIZES 50 TO 300 H.P.~



Side Walls of Erie City Water Wall Economics are made up of vertical 3" tubes, backed by 2" of refractory tile and 3" of high grade insulation. The whole is enclosed by a steel casing made up in panel sections. Cover plates provide easy access to the handhole plates opposite the circulator tubes in the upper headers and to the key caps in the lower headers. These key caps are arranged so that an angle expander can be used from the outside.

THE Erie City Standard Economic Self-Contained Boiler - Furnace Refractory Unit, used by thousands, has a "big brother"—the *water cooled* Economic. Side wall vertical circulator tubes, exposed to the fire, connected by squared seamless headers, backed by refractory, insulation and steel casing, serve a dual purpose. They provide greater steaming capacities while reducing refractory maintenance to the vanishing point.

The Erie City *Water Wall* Economic Boiler greatly extends the range of economical operation previously possible with ordinary fire tube boilers. It is designed to get the most from any mechanical firing method. These *Water Wall* Economics can be shipped completely built-up in sizes to 300 H. P. Write for booklet that illustrates in detail this modern Self-Contained Fire Tube Boiler with side *Water Walls.*

COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

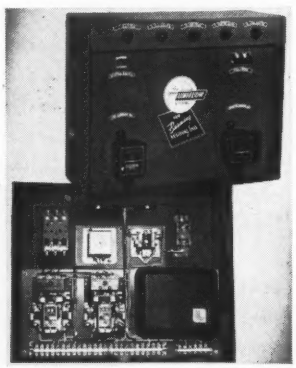
Complete Steam Generators ● Type C 3-Drum Boilers ● Type VL 2-Drum Boilers ● The "Economic" Boiler with or without Water Walls ● Welded H. R. T. Boilers ● Welded Steel Heating Boilers ● Coal Pulverizers ● Underfeed Stokers ● Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA *Since 1840*

greater safety, with less fatigue to operator. It drives nut or bolt 1750 rpm at free speed. At point of resistance, impact unit automatically delivers 3000 impact blows per min. and tightens to a torque of over 200 fp on a ¾ in. bolt.

Silman steel forgings and ball and roller bearings are used in the impact unit for maximum endurance. This unit can be removed and replaced in 45 sec if service is required. The complete tool is 12½ in long and weighs only 14½ lb. It comes with 25 ft cord with ground wire. Speed-O-Matic Sales, Inc.

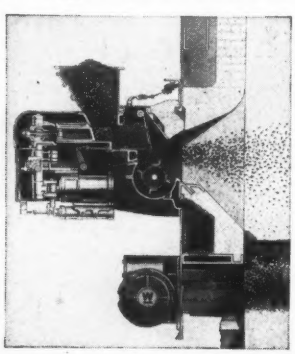
S Oil Burner Panel Board. Faster, more economical oil burner installation now may be achieved with the use of a new prefabricated control board. The new panel board is prewired at the factory so it is only necessary to supply power and connect the



oil burner on location. Because of the steel dead front it permits color-coded open type wiring so circuits can be traced with ease.

A system of red and green pilot lights is provided to enable the operator to see at a glance if burner is operating satisfactorily. A red light indicates danger in the particular operation identified by marker. Circuit breakers are used for protection of both the manpower and control circuit. Any type controls, including electronic, are available, as panel boards are tailor-made by the manufacturer to meet installation requirements. Partially fabricated panels are held in stock so prompt delivery can be made. Ace Engineering Co.

T Spreader-Type Stoker. Complete, economical combustion of any grade of coal, even lignite, is possible with the recently announced Centrafire spreader-type industrial stoker. In the

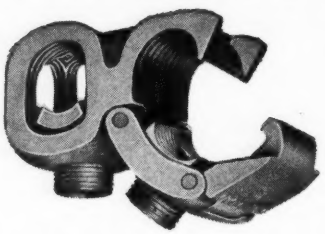


new stoker, coal is trajected by an air cooled, hydraulic motor-driven rotor so that it falls evenly over the entire length of a Link-Grate. Undulation of the central grate keeps the fuel bed active and moving toward the ash discharge grates at the sides. Ashes are discharged from the furnace without interrupting the coal feed, reducing load or loss of steam pressure.

A deficiency of primary air rising through the central Link-Grate is deliberately maintained. Resulting monoxides are burned in a turbulent secondary air supply above the trajectory of incoming fuels. An increased supply of the metered primary air is admitted through the side areas of the grate and ash-discharge grates to provide complete combustion. Coal is fed to the rotor by two long-stroke, slow-speed rams. A coal-feed equalizer plate driven from the rotor oscillates across the incoming fuel to assure a continuous feed whether the coal is wet or dry. One constant speed motor or turbine supplies oil pressure for all controls and drives. Eliminating all chain drives, this hydraulic drive permits maintaining accurately any preset fuel-air ratio. Westinghouse Electric Corp.

U Split Couplings. Three unit split couplings offer the trade a complete line of 12 sizes, ranging in conduit size from the new ½ to 5 in. The split coupling is recommended for any conduit within the range sizes, but particularly when the connection must be made in cramped space, also wherever it's impossible to screw L conduits into ordinary fittings.

The elimination of running thread means that all you have to do to assure a permanent connection is to butt the conduit ends together within the split coupling and tighten down two nuts. Bolt heads are held in place by the



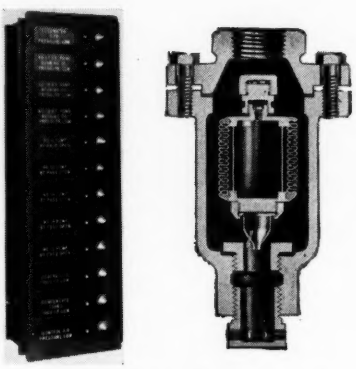
coupling shoulder. There is no need to twist the conduit. Spring steel lock washers prevent these nuts from loosening and the threaded inside of the coupling meshes with the conduit threads, giving a no slip, 'sure grip, permanent connection. As nuts are tightened, the smooth edges of the machined flanges fit snugly together, making a dust-tight joint. O. Z. Electrical Mfg. Co.

V Single Style Annunciator. This new single style of the ANF is one-half the width of its double style predecessors, and measures only 10 in. as compared with the 20 in. width of the double style. This reduction in width greatly facilitates installation in new or existing panel boards and control racks since it will occupy only one-half the room in width formerly required for the double style.

The size of the designation windows remain the same, 2 by 4½ in., and the ANF(S), as it is termed, may be made up of as many designation windows as required.

Featured in the ANF(S) is the unit method of construction. Each unit, one for each designation window, is a metal slide mounting two main lamps for illumination of engraved Lamacoid designation, a pilot lamp, and control relays. As many of these units as required may be housed in a single cabinet, with each unit jack-connected to the circuit to facilitate withdrawal from the annunciator cabinet without disturbing permanent wiring connections. All units are accessible from the rear of the cabinet.

In actual operation, illumination of the designation windows is accomplished by the closing of a control relay actuated by a supervisory, or trouble contact on the equipment under supervision. At the instant of closure, and subsequent designation illumination, a remote audible alarm is sounded, which continues until the push-pull type switch adjacent to that particular designation is pulled. One of the features of the ANF(S), however, is the fact that silencing of the audible alarm for one trouble indication does not prevent the operation of the same audible alarm in the event of additional trouble. Autocall Co.



Left: Annunciator. Right: Air Vent

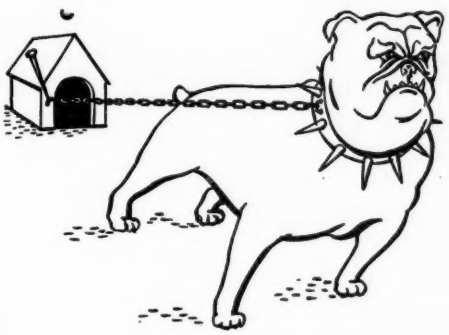
W Air Vents. Greatly increased air venting capacity is the feature of this new line of high pressure air vents for industrial steam equipment. Powerful phosphor bronze helical bellows with relatively large diameters permit over-size valve orifices at pressures 0 to 200 psi.

Maker recommends installation on equipment such as steam jacketed kettles, calendar beds, canning retorts, rotary dryers, laundry ironers, etc.

These high pressure air vents have renewable heads of stainless steel, bodies and bonnets of cast brass, cast iron, or semi-steel depending on the size and pressure. Available in vertical and angle patterns. Sizes, ⅜ to 1¼ in. Sarco Co., Inc.

X Wire Stripper. A simple twist and a pull are all that are required to strip insulation from No. 12 to 22 solid or stranded wire with the new Quick-Strip wire stripper. The tool consists of a round, hardened blade attached to a plastic handle of various colors. The blade contains four calibrated slots. Three slots accommodate and strip various size wire and the

The "Uni-Matic" Oil Purifier is like a WATCHDOG



A DE LAVAL Oil Purifier is always mechanically alert for trouble. Operating on continuous by-pass, it keeps the turbine lubricating oil clean and free from impurities and moisture which normally get into the system. These impurities and water tend to form sludge, so that the Purifier literally helps to prevent sludge formation. Equally important in an emergency is the fact that if an unexpected major water leak develops, the De Laval Purifier can continuously dehydrate the oil and thus prevent serious damage to the turbine.

The "Uni-Matic", the type of De Laval Oil Purifier most generally used, provides a complete oil purification plant, compact and fully enclosed. It includes pumps, gages, and all necessary accessories for keeping oil in the best possible condition. The machine is direct motor driven, self-lubricated, and ball-bearing equipped. The bowl in which purification takes place by centrifugal force is self-draining and of the "constant efficiency" type.

- Write for Bulletin TO-1.

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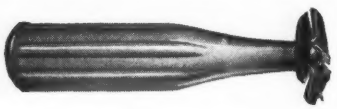
LUBRICATING OIL PURIFIERS

fourth cleans the wire. The tool removes not only the rubber, fabric or plastic insulation but cuts and removes braided wire shielding. The device is small, sturdy and compact, ideal for



use in close quarters. Blade may be resharpened or is easily replaced. The Quick-Strip is valuable for electricians, mechanics and industrial maintenance men. Jaco Products Co.

Y **Bulk Materials Truck.** An electric power industrial truck equipped with a special type of scoop is announced. This is for picking up, transporting, delivery or piling loose materials used in many manufacturing and construction operations. The scoop is attached to the truck's tilting and elevating mechanism and all controls are centralized at the driver's station. A tripping device on the scoop provides for rapid discharge of the load. It also has a pneumatic snubber to cushion impacts. When the scoop is lowered to floor level it assumes its normal shoveling position. Providing for ready adjustment to local conditions, the truck's upright column may be tilted forward 5 deg from perpendicular. For safe carrying of the load and to avoid spillage, the upright column may be tilted backward 15 deg from perpendicular. Flexibility of the machine facilitates loading or emptying the scoop at floor levels or at any height up to 117 in.

Capacity area of the scoop is 12 cu ft; capacity weight of load is 2000 lb. Speed of the truck with load ranges up to 5½ mph. The combination of lift truck and scoop is especially adaptable in plants or areas where bulk materials are handled, such as related to chemicals, paints, glass, cement, coal, sand; and also in metalworking industries where large quantities of metal chips and similar scrap must be moved. The scoop is interchangeable with a standard type fork, thereby adopting the truck at any time to a still wider range of time-saving, load-handling purposes. Elwell-Parker Electric Co.

Z **Starting Switches.** A new line of manual starting switches for use with fractional-hp motors has been announced. The new switches are furnished in five different types: with general-purpose enclosure; without enclosure; a combination unit and selector switch; with cast iron encolsure for wet locations, and a similar type for dusty or hazardous locations. The switches are desirable for use with fractional-hp motors driving blowers, pumps, ventilating systems, small machine tools, and a wide variety of similar applications.

A feature of all five types is a molded base of moisture-resisting insulating material which mounts and encloses the mechanism and contacts. This construction not only protects the operating parts from dust and physical contact, directs the heat concentration to the sturdy bimetallic tripping device, thus assuring that the action of the overload is quick and positive. Another feature is the action of the switch handle, which moves to the off position on overload, thus giving indication that the power is shut off. The wheel-type movable contact cleans as it rolls against the stationary contacts, and, in addition, recedes into a recess in the base, thus effectively snuffing the arc.

All parts of these switches are rust-resisting, readily accessible wiring terminals on the tops of the units facilitate easy wiring, and the screws for fastening the molded back cover are attached to the cover to prevent their being lost. Control Div., General Electric Co.

AA **Tote Box Truck.** A new box for tote boxes has a double-hook feature which enables the hook-arm to bite into totally closed wood boxes or cases; or into open boxes; while the upper hook conveniently takes hold of handles on metal tote boxes, etc. Easy manipulation of the hook-arm is made possible by the convenient hand grip on the arm itself.

When the load is hooked, the operator merely pulls backward and the load slides easily onto the balanced tilting carrier plate. Bulky boxes can be "tumbled" onto the carrier plate.

To discharge, a slight push with the hook-arm overbalances the carrier plate and allows load to slide gently to floor.

The tilting carrier plate is constructed of parallel steel plates and is balanced so the forward movement of the hook-arm places it in loading position. In pulling position or when a load is being hauled, the carrier plate is automatically tilted back off the floor.

Of rugged, all-steel welded construction, the Hook-'N-Haul is equipped with one swivel and two stationary casters, either steel or rubber, and can be easily turned in its own axis. Painted "fire-engine red" for quick locating when needed. Techtmann Industries.

BB **Motor Speed Reducer.** This new all-steel Motoreducer is an improved model of the original Motoreducer. The new all-steel housing practically eliminates accidental damage. It is equipped with a newly developed dirt-proof and moisture-proof seal which protects gears and bearings against contamination of the lubricant by moisture and dirt. Shaft diameters have been increased to provide greater torsional strength and considerable increase in overhung load capacity. The complete line includes horizontal and vertical units in both integral and all-motor types, for floor, wall or ceiling mount. The basic Motoreducer unit can be converted to right angle, V-belt, multi-speed, low ratio, ceiling mount and many other adaptations.

It can be used to drive mixers, agitators, conveyors, pumps, dust collectors, screens, classifiers, vats, fans, washers, line shafts, and other equipment. Falk Corp.

CC **Electrostatic Voltmeter.** A new portable electrostatic voltmeter designed to meet the need for a high-impedance, high-voltage instrument in laboratory and industrial testing, has been announced.

Available in five ratings, 40, 50, 60, 70, and 75 kv, rms, the instrument can be used to measure applied voltage during dielectric test, to study electric phenomena, to determine peak voltage by the vacuum-tube method, to measure exceptionally high voltage when used with a votlage divider, and to determine the peak voltage output of magnetos.

Housed in a cylindrical steel case 21½ in. in dia, it weighs approximately 50 lb. The high-voltage connector projects about 12 in. above the top of the 35 in. high case. The moving system consists of two fixed electrodes between two small metal spheres that revolve on a pivoted shaft on which are mounted aluminum damping vanes, a mirror, and a spring. The mirror reflects a beam of light onto the scale, indicating the position of the moving electrode.

The moving system is insulated from the case and is connected to the high-voltage terminals through a current-limiting resistor which serves as a protective device when voltages in excess of flashover values accidentally are applied. A minimum number of insulating supports are used between the moving system and the case to permit the insulation resistance to be as high as possible. The top insulating plate upon which the resistor housing is mounted is made of plexiglass to allow inspection of the moving element without disassembling the instrument. Meters and Instruments Div., General Electric Co.

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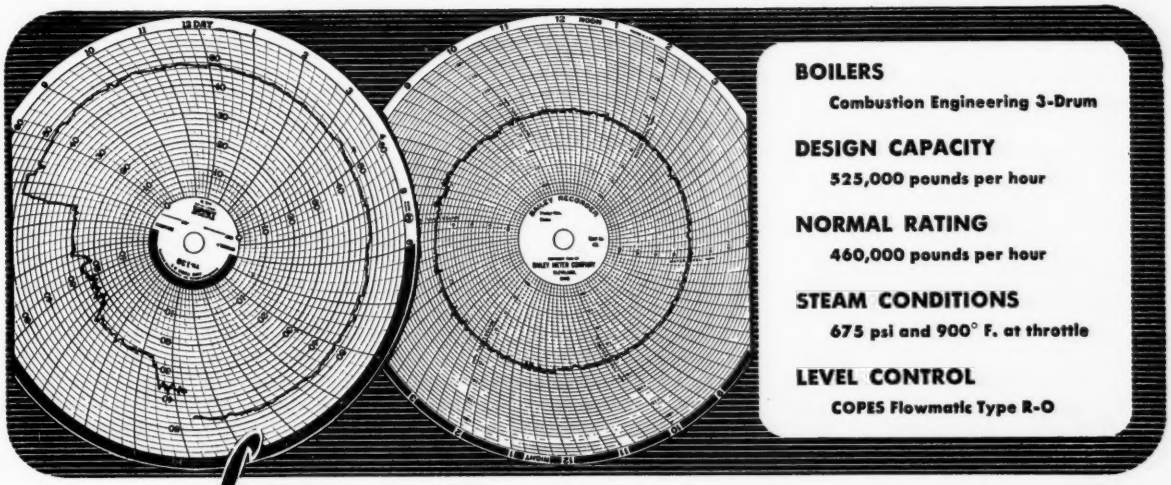

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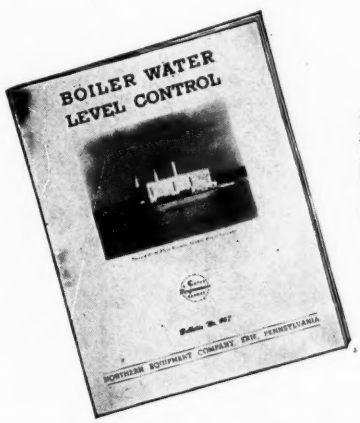

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Yarway Remote Liquid Level Indicator with Control Unit attached.

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The Yarway Liquid Level Indicator, equipped with Yarway Control Unit and auxiliary electric signalling devices, provides this check at two or more locations anywhere in the plant.

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The Control Unit may also be used as a control for mechanical equipment such as motor-operated valves, pumps, etc.

FOR COMPLETE DESCRIPTION AND SPECIFICATIONS OF YARWAY REMOTE LIQUID LEVEL INDICATORS, WRITE FOR BULLETIN WG-1822.

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WHAT LEADERS SAY

Why Stream Pollution Concerns Power Engineers

By J. R. HOFFERT

WHY SHOULD stream pollution abatement especially interest mechanical engineers? Let me say that it should interest all of you as citizens concerned with the well-being of your community and the preservation of its natural resources; the protection of the good quality of your water supplies—both potable and industrial; the safeguarding of the valuable fish life of our streams and coastal waters and the preservation of our recreational resources, just as, for instance, as citizens we need to be concerned with soil conservation, good government, and the many other measures affecting our national and individual well-being.

Does all this call for too much altruism to interest you? If so, then let me remind you that you should be concerned with pollution abatement because it is going to cost a lot of money which you will individually help pay, partly in the form of taxes and partly in the increased cost of the products of industry which you buy.

But over and above these reasons which you are share with all your fellow citizens, there are other reasons peculiar to your special calling. For instance, the mechanical engineer is frequently in fact or in effect the maintenance engineer of the industry, or he is the "plant engineer" who is directly or indirectly responsible for keeping its production facilities and its "services" in going condition. As such he will in many cases be saddled with the additional responsibility of operating or supervising the operation of the plant's sewage or industrial waste treatment works.

This is especially so because these works are becoming increasingly mechanized not only to reduce the manual labor involved, but sometimes because of space limitations, the nature of the plant or its production process, for recovery of by-products, and for other reasons. Indeed, many modern treatment works are literally factories for turning noxious substances into innoxious end products or by-products and are a maze of piping, pumps, motors, compressors, measuring and recording devices, and all the gadgets that delight the heart or gray the hairs of the mechanical enginers. So great is the mechanical equipment of the large municipal treatment works that there is need for a mechanical engineer to devote his full time to its maintenance and this can be true in some industrial plants too.

Again, stream pollution is of interest to the mechanical engineer because it may vitally affect the production processes or plant practices for which he is responsible. For instance, there is the segregation of certain waste waters; the collection of spent liquids; the recirculation of such things as the cutting oils, the handling of oil soaked turnings in a machine shop, the lubricating oil in a railroad shop and all sorts of process waters in industrial plants; the disposal of wash water from a foundry sand recovery plant; the disposal of boiler blowdown water; and countless other matters which have a vital connection with pollution abatement. His special knowledge may enable him to prevent pollution by rearrangement of plant processes or machine layout; or by recirculation, treatment, and re-use of water. He may be able to cut down the cost of treatment, cause it to "break even" or even produce a profit from a by-product.

It is unnecessary for me to remind many of you of the reduced maintenance problems, to say nothing of costs, which you would experience if condenser tubes weren't slimed or encrusted by stream pollution; of the reduced corrosion you would experience or the lessened boiler water or process water treatment you would face if stream pollution were reduced or eliminated.

There is still another reason for your interest in pollution abatement. As I said before, treatment works are becoming increasingly mechanized and there are many specialized mechanical devices and much equipment designed especially for these purposes. For instance, the present day non-clogging centrifugal pumps are largely the result of the development of the pumps for handling New Orleans' sewage. A whole new field of mechanical design has been opened up or expanded by the needs and opportunities of waste treatment. Some of you may be engaged in the development, manufacture, or sale of such equipment and to you pollution abatement may mean "bread and butter," or it may offer a fine outlet for your inventive genius because many, many improvements are needed in this field.

In considering stream pollution, your viewpoint is of vital importance. Unless you have been engaged in some phase of pollution abatement you have probably considered the subject, if at all, from the production man's standpoint; of the effect of the "other fellow's" pollution upon your plant, or as just an ad-

(Continued on page 112)

J. R. Hoffert is chief engineer of the Department of Health, Commonwealth of Pennsylvania. He was born at Omaha, Nebraska, was graduated from Cornell University with degree of C. E. (Fuertes Gold Medal, Sigma XI, Tau Beta Pi).

He then served in the Bridge and Construction Department of the Pennsylvania Steel Co., later became engineer and assistant superintendent, Harrisburg Park System and then was progress engineer in construction of Edgewood Arsenal, Edgewood, Md.

Since August 1, 1919, he has been successively assistant engineer, district engineed, chief of design and construction section, civil engineer, assistant chief engineer, and now chief engineer of the Pennsylvania Department of Health; also, until 1946, he was Secretary of the Sanitary Water Board.

He is a member of American Society of Civil Engineers; Society of American Military Engineers; Pennsylvania Sewage Works Association; and Pennsylvania Water Works Operators Association.

The foregoing comments are extracted from a paper he delivered before the 1947 Annual ASME Meeting. That stream pollution is a live public issue and that the public will and can bring pressure on engineers to abate it (along with smoke) is evidenced by such general magazine article as Our Poisoned Waters, by Bill Davidson, Colliers, October 16, page 20. Also note the constantly increasing emphasis on existing and new equipment for industrial waste treatment in the advertising of manufacturers of instruments and controls, and water treatment and chemical equipment

New Power Plant of Lee Paper Company at Vicksburg, Michigan

Modernization program, involving complete electrification of high-grade paper mill started before the war, completed recently with the installation of a 2500-kw condensing extraction turbine generator and a 400 psi pulverized coal fired boiler. All work carried out without interruption of power services

THE LEE PAPER COMPANY is located at Vicksburg, Michigan, 14 miles from Kalamazoo and 152 miles from Chicago on the Grand Trunk Railroad. The plant, built in 1904 manufactures high grade printing and writing paper. The paper made at the Lee mill is made from rags as well as from wood pulp. The pulp used comes from the east and west of the United States, Canada and Sweden.

Until 1939 practically all of the power used in the mill was produced by steam engines, the engines being mechanically coupled to the paper machines. At that time, however, a 1000 kw turbine-generator unit was installed, also an 800 kw engine-driven generator. This was the first step in a modernization program which had as its object the complete electrification of the mill. This program was interrupted by the war and it was not until 1945 that it was resumed. The mechanical drive engines were taken out and replaced with electric motors. At one time there were seven Corliss engines of varying size and manufacture scattered throughout the mill.

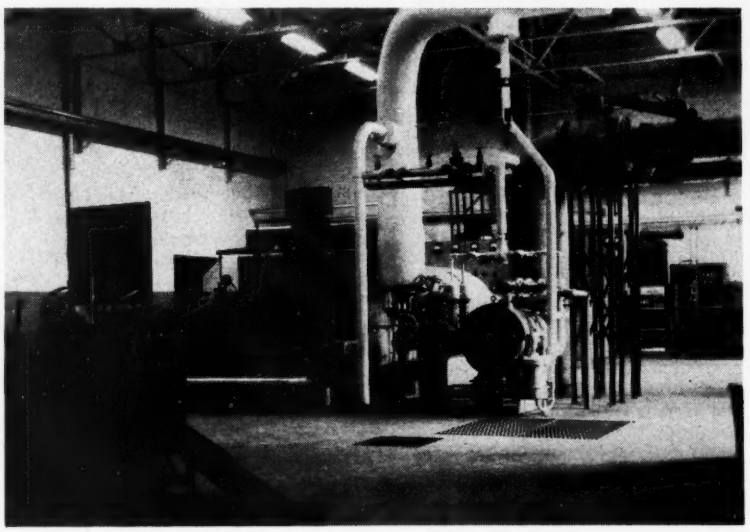


Fig. 2 View in the turbine room showing the new 2500-kw turbine generator. Note use of fluorescent lighting

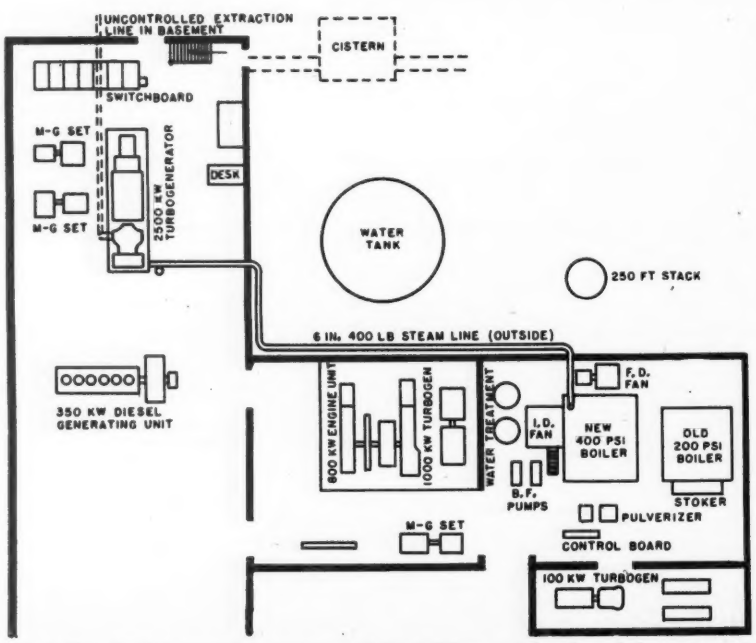


Fig. 1 Plan showing general arrangement of the buildings and location of the equipment

New 2500 Kw Turbine Generator installed

Under the direction of C. M. Daniels, chief engineer in collaboration with M. D. Bardeen, president of the Lee Paper Company, plans for a new power plant were drawn up and equipment ordered. This involved the installation of a 2500 kw condensing extraction type turbine generator and a 60,000 lb per hr integral furnace boiler designed for operation at 400 psi, together with the necessary auxiliaries.

All construction work had to be carried out without interruption to the power service. While the new turbine unit was being installed, the electrical load was carried by the 1000 kw turbine and the 800 kw engine driven unit supplemented by power purchased from the local utility company. The old, low pressure (200 psi) boilers, remained in

service while the electrification program was being carried out.

In constructing the new power plant, it was deemed expedient to make use of the existing buildings. The arrangement of the equipment is shown in Fig. 1 and the accompanying photographs show the general appearance. Despite the fact that the new equipment was installed in old buildings, the plant is spacious with ample room around all pieces of equipment for ease and convenience of operation and maintenance.

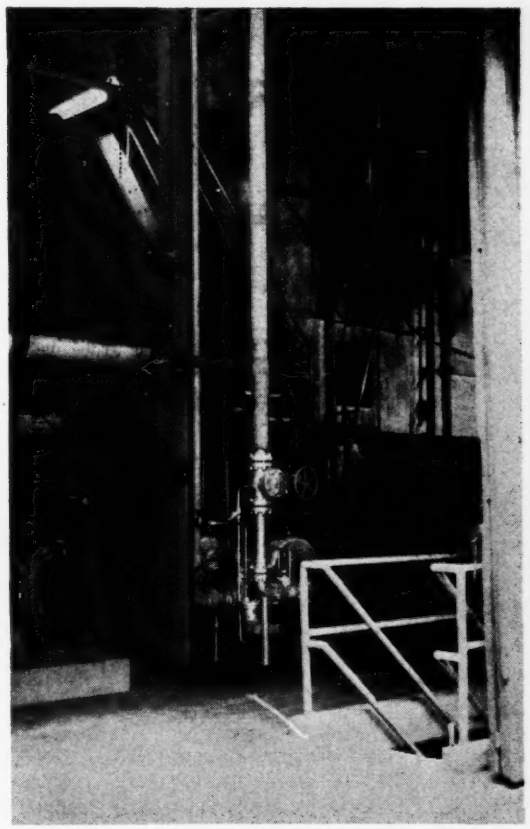


Fig. 3 Looking into the boiler room where the new 400 psi boiler is installed

New Equipment Installed in Existing Buildings

As indicated in the plan, Fig. 1 the turbine and its associated equipment is located in one wing of the mill buildings while the boilers are installed in another portion at right angles. This arrangement led to the installation of the main high pressure steam line to the turbine, outdoors along the walls of the building. This made possible a direct route and one which involved a minimum of cutting through walls and floors. The line is well insulated, so that the heat loss is little more than would be the case if the line were installed indoors.

The new turbine generator unit is a General Electric Co. condensing-extraction machine, rated at 2500 kw, 480 v, 3-phase, 60 cycles, with direct connected exciter. The turbine operates at 400 psi at the throttle and exhausts into a C. H. Wheeler surface condenser. The turbine is provided with two extraction points, one at 20 psi and the other at 50 psi. Circulating water for the condenser is obtained from a nearby pond. Water from this pond drains into a cistern just outside the turbine room from which it passes to the circulating pumps. The condenser is provided with two Warren circulating pumps and two condensate pumps. A small centrifugal pump supplies water to the oil cooler, the turbine bearings and the generator air cooler. All of these auxiliaries are motor driven.

The Boiler Room

Steam for this new turbine is generated in a 60,000 lb per hr Babcock & Wilcox integral furnace boiler, built to operate at 420 psi and at 750 F. This unit burns pulverized coal but is provided with an oil burner which is used when starting up. Pulverized coal is supplied by two B & W pulverizers installed on the operating floor in front of the boilers. Coal is handled by a Stephens-Adamson conveying system.

The boiler is served by both forced and induced draft fans and by an air heater. The latter is a B & W plate-type heater and the fans are Clarage units. The forced-draft fan is driven by a 40 hp, 1755 rpm General Electric motor, while the induced-draft fan is driven by a two speed induction motor, rated at 75/50 hp and operating at either 1185 or 885 rpm.

Since this mill manufactures high-grade printing and writing paper, it is necessary to guard against the spread of dust and fly-ash as much as possible. To this end, a Prat-Daniel dust collector is provided.

The boiler is operated under complete Bailey automatic combustion control from a panel located on the operating floor in front of the boilers. It is fitted with Diamond Power Specialty Co. manually operated soot blowers, Babcock & Wilcox blowoff valves, Lunkenheimer stop-and-check valves and a Copes feedwater level regulator. Ash is handled by a United Conveyors Corp. pneumatic ash handling system. Boiler water concentration is controlled by a continuous blow-down system.

A simple diagram of the steam system is shown in Fig. 4. As shown, the 400 psi boiler supplies steam to the turbine through a 6-in. line which, as already explained, is installed mostly outdoors. The turbine is provided with two extraction points, one at 20 psi and the other at 50 psi. The 20 lb extraction line going to the paper machines is automatically controlled but the 50 lb

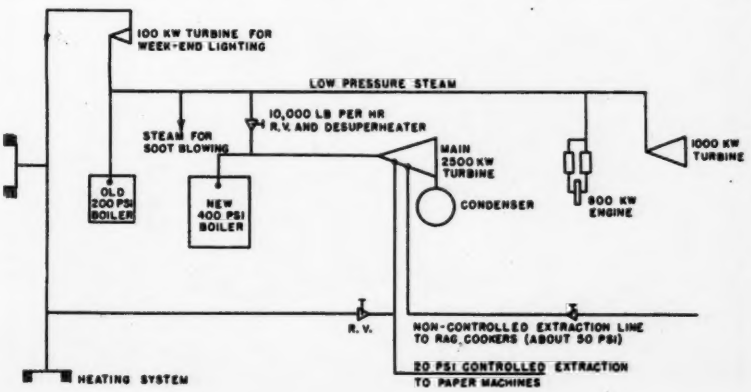

100 KW TURBINE FOR WEEK-END LIGHTING
LOW PRESSURE STEAM
10,000 LB PER HR R.V. AND DESUPERHEATER
STEAM FOR SOOT BLOWING
MAIN 2500 KW TURBINE
1000 KW TURBINE
OLD 200 PSI BOILER
NEW 400 PSI BOILER
CONDENSER
800 KW ENGINE
R.V.
NON-CONTROLLED EXTRACTION LINE TO RAG COOKERS (ABOUT 50 PSI)
20 PSI CONTROLLED EXTRACTION TO PAPER MACHINES
HEATING SYSTEM

Fig. 4 Diagram showing the steam piping system

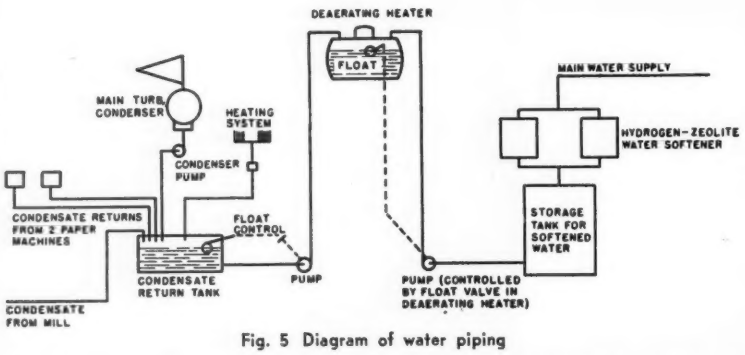


Fig. 5 Diagram of water piping

line which supplies the rag cookers is not under automatic control.

Old Boiler Retained as Standby

The old 200 psi boiler is retained as a standby for emergency use and when additional generating capacity is required. As shown, this boiler supplies the old 1000 kw turbine and the 800 kw engine-driven generator. The old boiler also supplies a small 100 kw turbine generator installed to carry the lighting load over week-ends, and other times when the main unit might be out of service. This turbine is a non-condensing machine exhausting directly to the heating system. The heating system, as shown, can also be supplied from the 20 psi extracting line through a reducing valve.

A 10,000 lb per hr Elliott reducing valve and desuperheater is installed between the 400 psi line and the line from the 200 psi boiler. When the old boiler is in service, this line is operated at 200 psi to run the old engine and turbine. At other times, when the reducing valve and de-superheater is in operation, the line is operated at 165 lb pressure.

A simplified diagram of the water system is shown in Fig. 5. Raw water from the water supply is pumped directly to two Permutit hydrogen-zeolite water softeners. Softened water is stored in the storage tank, which has a float control, on the line to the Elliott deaerating feedwater heater.

Condensate from the turbine condenser, from the paper machines and returns from the heating system all drain, or are pumped, into the main condensate return tank as shown. From this tank, the water is pumped into the deaerating heater.

Two Ingersoll-Rand boiler feed pumps are provided. These are 6-stage, 128 gpm, 1320 ft head centrifugal units, one driven by a 75 hp 220/440 v G.E. induction motor and the other by a 57 hp, 400 psi Elliott steam turbine. Feedwater level in the new boiler is controlled by a Copes feedwater regulator. In addition to the zeolite feedwater treating, boiler water is treated with phosphate, introduced by Milton Roy phosphate pumps.

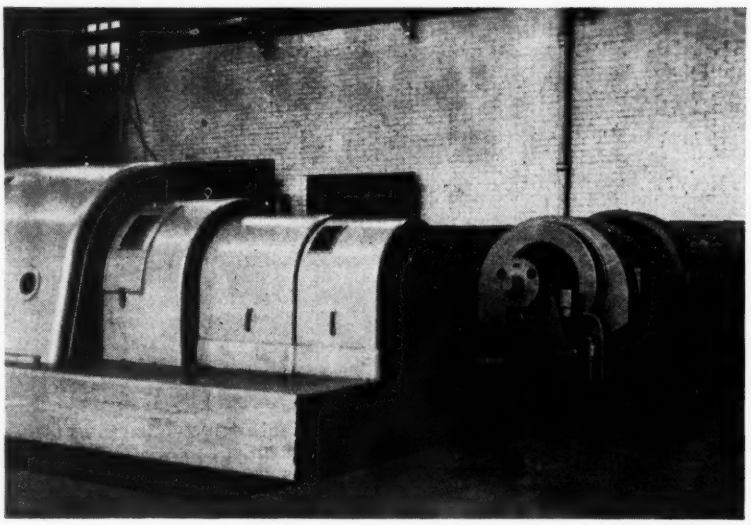


Fig. 6 View in turbine room showing the exciter end of the main generating unit and one of the two motor generator sets

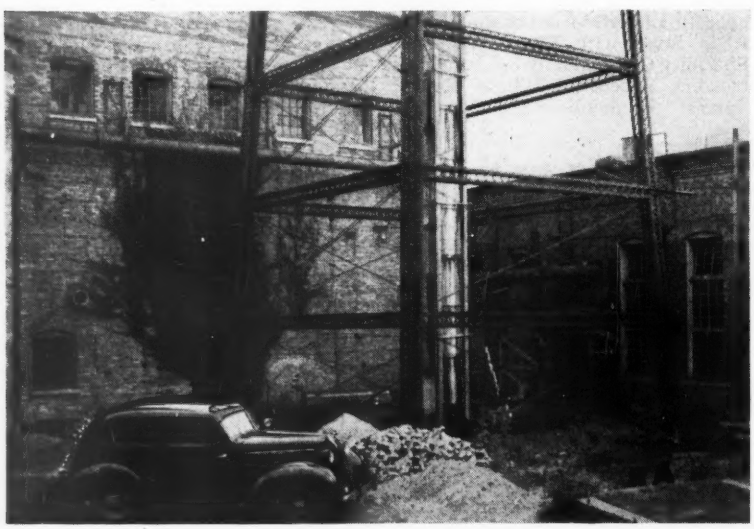


Fig. 7 Outside view, showing high pressure steam line along wall of building

Figure 1 shows the location of the old boiler which is fired by a Taylor stoker, and the 1000 kw turbine and 800 kw engine. For normal operation these units are not needed, but they are available for standby service. On weekends the small 100 kw, General Electric turbine generator is used to supply the lighting load. This unit, as shown, is installed in a separate room, just off the boiler room so that both boiler and turbine can easily be cared for by one operator. This room also contains two 7 by 7 in. Ingersoll-Rand air compressors.

Direct current, which is used for some equipment in the mill, is supplied by two General Electric motor generator sets. One of these consists of a 580 hp, 480 v synchronous motor driving a 400 kw, 250 v, d-c generator and the other a 250 hp motor driving a 150 kw, d-c generator. These motor-generator sets are

(Continued on page 77)

The Liquid Rheostat for Control of Larger Motors

Liquid rheostats have been used for many years, sometimes as make-shift arrangements in testing large equipment, in others as permanent control devices; little, however, has been written about them. This article discussing their construction and use is an abstract of a paper delivered by the author before the American Institute of Electrical Engineers. It covers descriptive part of paper. Those interested in the mathematical analysis of load characteristics and control systems may refer to original paper

By G. L. McFARLAND and WILLIAM ALVAREZ Both of General Electric Company, Schenectady, N. Y.

LIQUID RHEOSTATS have been in use for many years but there has been surprisingly few technical articles written describing the basic design and features of these devices. This article has been written to acquaint the power engineer with the basic design of modern liquid rheostats and types of loads and control systems.

Speed control systems using the liquid rheostats are noteworthy for their stepless speed control, minimum maintenance and maximum dependability. Most applications in recent years have been for motors ranging from 1000 hp to 30,000 hp. They are well adapted for the acceleration and speed adjustment of wound-rotor induction motors driving centrifugal pumps, fan drives and steel mill motors.

Basically, the liquid rheostat consists of metal electrodes in a tank of electrolyte, usually a solution of a few per cent of sodium carbonate by weight in clean water. The sodium carbonate should not contain more than ½ per cent of sodium chloride or sodium sulfate or more than 1 per cent of sodium bicarbonate if maximum electrode life is to be expected. Current flows between the electrodes through the electrolyte, the resistance between the electrodes being approximately proportional to the distance between them.

To insulate the stationary electrodes from the steel tank and from each other, an insulating cell is used around each pair of electrodes. Cell construction is typified as open cell or closed cell construction. The closed cell design is used when a high value of resistance per phase is required at maximum electrode spacings, such as for centrifugal fan, pump, and compressor load applications. The open cell design is used where relatively low resistances per phase are required, as for constant torque loads. Smooth speed control is obtained by varying the resistance in each phase of the motor secondary, the resistance being varied by raising or lowering the movable electrode.

Figure 1 shows a schematic drawing illustrating the internal design of a liquid rheostat in which the three insulating cells are mounted in one electrolyte tank. Details of the closed cell construction are shown in Fig. 2. Resilient gaskets between the insulator and the steel tank prevent leakage of the electrolyte. Inlet pipes, which introduce electrolyte beneath the lower electrode, are made from hard rubber as they must not short circuit the resistance path between the electrodes. For electrodes up to 10 in. in diameter, cells

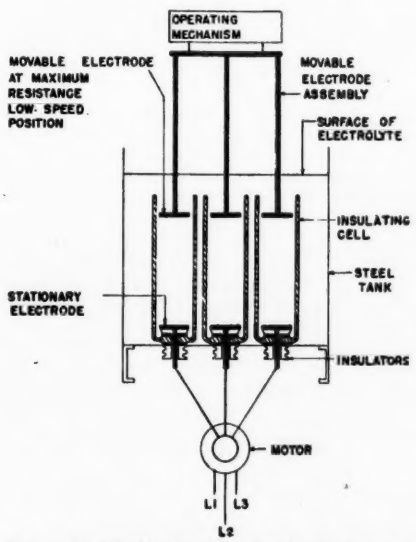


Fig. 1. Liquid rheostat with closed cell construction, forced circulation of electrolyte. External heat exchanger for cooling electrolyte not shown

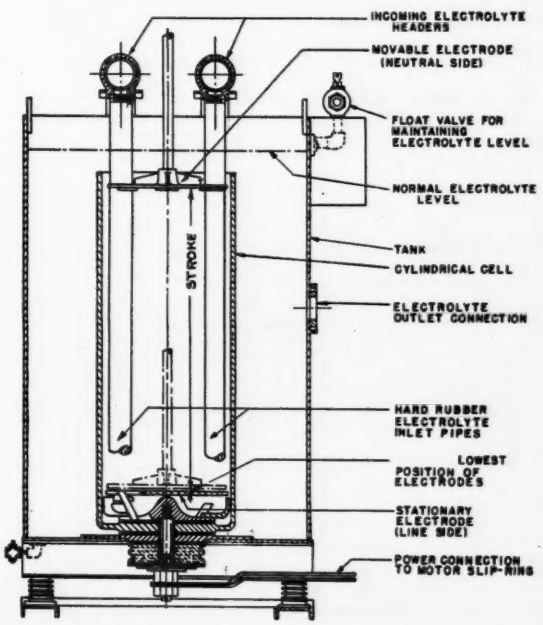


Fig. 2. Cross section of closed cell design showing incoming electrolyte headers which feed electrolyte below lower electrode

are made from a ceramic material. For larger sizes, rubber coated steel cells are used for greater strength.

Figure 3 shows the open cell design in which circulation ports near the lower electrodes allow the electrolyte to circulate up through the cell and out over the cooling coils by thermal convection. Phase insulation between cells required to prevent excessive current leakage between the stationary electrodes.

Since the resistance of the rheostat is to be easily changed, the movable electrode assembly is connected to an operating mechanism of some kind. These mechanisms may be:

1. Pilot motor
2. Torque motor
3. Air cylinder
4. Hydraulic cylinder
5. Manual device

The movable electrodes are partly counterbalanced with weights to minimize the power required to move them.

The power loss in the electrolyte between electrodes is instantly absorbed by the electrolyte itself, thus raising its temperature in the portion carrying current. The horsepower dissipation rating of the rheostat then depends upon the means for cooling the electrolyte.

Makeup water is required to maintain constant electrolyte level as slight evaporation and hydrolysis occurs. As in the case of the water originally used to fill the tank, makeup water should be clean and suitable for drinking purposes.

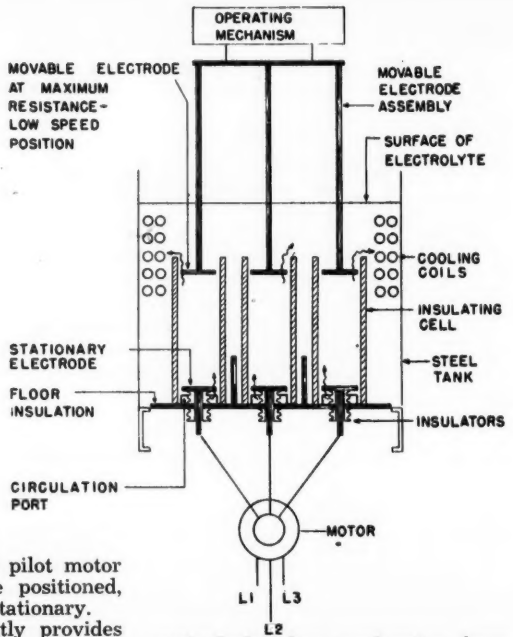
Control Systems

1. Manual Control System. One of the simpler methods of speed adjustment is illustrated in Fig. 8. The electrodes are positioned to obtain any desired operating speed by manual control for the pilot motor on the rheostat. Once positioned, the electrodes remain stationary.

This scheme inherently provides smooth or "stepless" speed adjustment. The accuracy with which speed is maintained at fixed electrode spacing depends on constancy of the load torque and electrolyte temperature.

The temperature regulating valve which is usually provided in the electrolyte circulating system serves to maintain the electrolyte temperature within reasonable limits. However, the thermal storage in the volume of electrolyte and the fixed pumping capacity results in a time delay for the electrolyte temperature to respond and reach a steady operating value. This thermal lag is reflected as a drift in speed after each change in speed setting and particularly after acceleration from rest.

Fig. 3. Liquid rheostat with open cell construction. Gravity circulation of electrolyte. Cooling coils for cooling electrolyte mounted in rheostat tank



2. Speed Regulating Control System. A more refined scheme of speed adjustment is illustrated in Fig. 9. The pilot motor on the liquid rheostat is energized by an amplidyne. The amplidyne, in turn, responds from the control unit, which compares the speed adjustment setting of the speed-adjusting rheostat with the motor speed, as detected by the tachometer generator. Any divergence, from the desired setting results in smooth, automatic positioning of the electrodes to correct and maintain the speed within precise limits. Current limit action is usually provided to prevent the motor current from exceeding a preset value during acceleration.

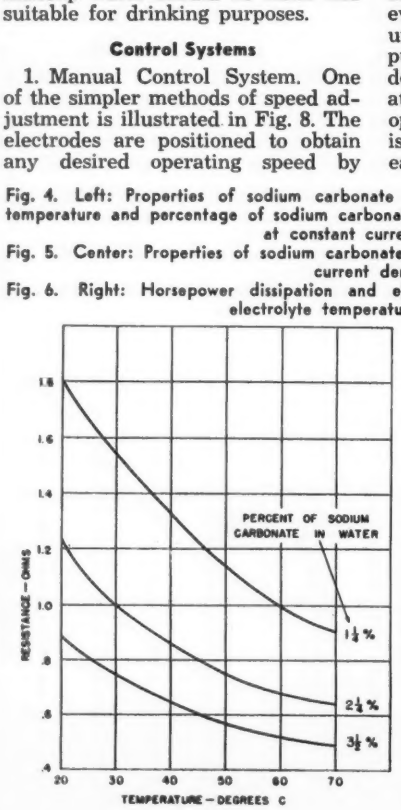
The speed regulating control system has several features and advantages as follows:

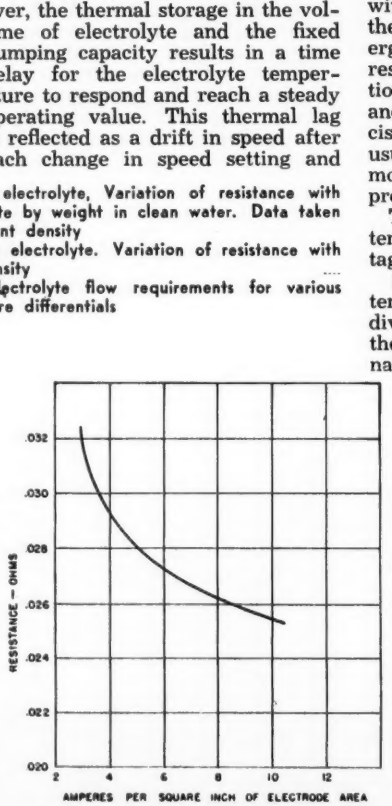
(1) It is a variable response system, i.e., when the motor speed diverges from the desired setting, the magnitude of the correction signal is directly proportional to the

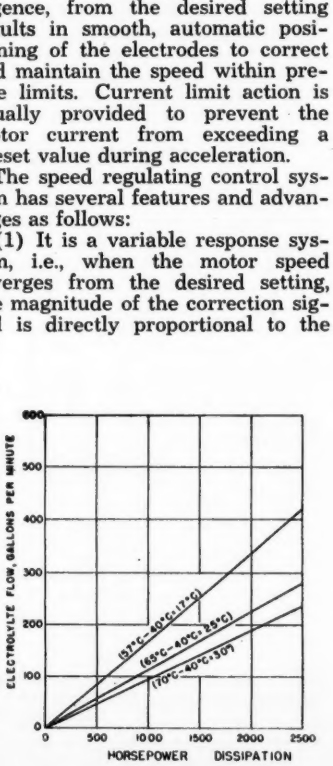
Fig. 4. Left: Properties of sodium carbonate electrolyte, Variation of resistance with temperature and percentage of sodium carbonate by weight in clean water. Data taken at constant current density

Fig. 5. Center: Properties of sodium carbonate electrolyte. Variation of resistance with current density

Fig. 6. Right: Horsepower dissipation and electrolyte flow requirements for various electrolyte temperature differentials







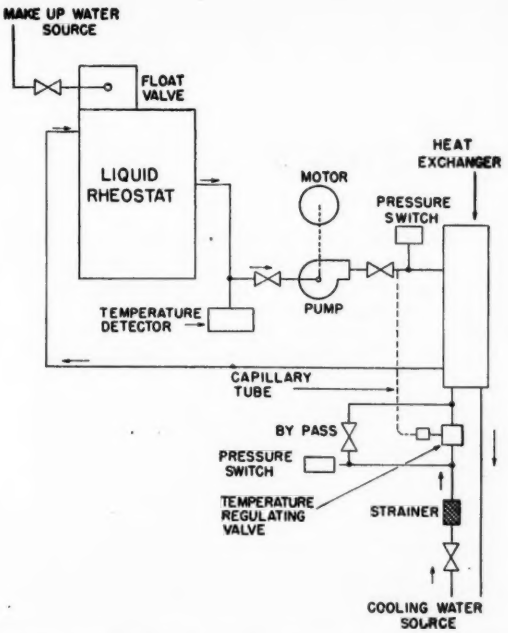


Fig. 7. Piping diagram for liquid rheostat with external heat exchanger

value of the divergence. This means that for a large divergence in speed, the electrodes move rapidly to correct the speed. Conversely, for a small divergence, the electrodes move slowly to correct speed. From an operating standpoint, the variable-response system results in fast response with stable operation.

(2) It provides current-limit acceleration.

(3) It virtually eliminates fluctuations in speed otherwise caused by electrolyte temperature drifts. This means that the speed at any setting is reached quickly and is thereafter maintained within close limits.

3. Load Regulating Control System. This scheme is illustrated in Fig. 10 and is usually applied to maintain constant input to the motor or to prevent the load on the motor from exceeding a selected value.

The torque motor on the liquid rheostat is energized by an amplidyne. The amplidyne in turn, responds from the control unit, which compares the load adjustment setting of the load control rheostat with the primary current. Variations from the desired setting cause automatic positioning of the electrodes to vary the speed to maintain essentially constant input to the motor. The electrode operating mechanism is designed to make possible very rapid movement of the electrodes.

The load regulating control system can be adapted as follows:

(1) To regulate and maintain operation at essentially constant torque.

(2) To operate as a current-limiting or "cushioning" control under rapid or impact load changes of short duration. The drive usually includes a heavy flywheel, and the drive motor is intended to operate at essentially constant speed. For normal loads the electrodes are in the "down" or maximum speed position. When a heavy impact load occurs, the sudden increase in motor current causes the electrodes to operate very quickly and insert resistance in the rotor circuit. This tends to decrease the motor speed. However, the flywheel minimizes the speed change by giving up some of its kinetic energy. The net result is that the power input to the motor is held within the load setting. When the impact load disappears, the electrodes automatically return to the maximum speed position.

Other Control Systems

The liquid rheostat, as a system element, in conjunction with the proper control, can be applied in various other ways. In some cases, a pneumatic or hydraulic cylinder can be used to operate the electrode mechanism directly. The cylinder, in turn, is positioned from a regulating control sensitive to any desired quantity such as:

1. Temperature
2. Flow
3. Level
4. Pressure

The liquid rheostat is particularly suited for control of larger motors, where other types of control cannot be used because of rating limitations. For the smaller motors the liquid rheostat is on a more competitive basis with other types of control. However, on these smaller sizes, an integral assembly comprising liquid rheostat, heat exchanger, circulating pump, and other associated devices, together with the features of stepless and precise control, will doubtless lead to wider use in the future of the liquid rheostat for control of smaller motors.

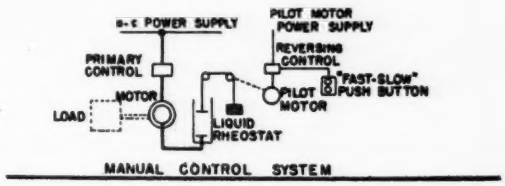


Fig. 8. One-line diagram of a manual control system

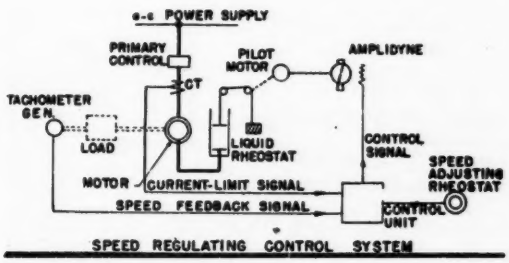


Fig. 9. One-line diagram of a speed regulating control system

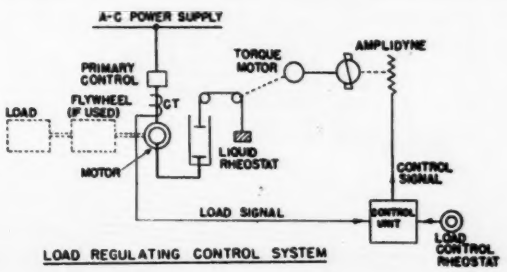


Fig. 10. One-line diagram of a load regulating system

How to Maintain Cooling Towers

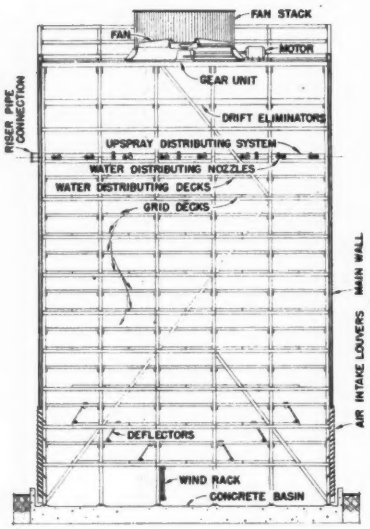


Fig. 1. Cross-section through counterflow induced-draft cooling tower, showing essential parts of tower

Follow these practical detailed directions to get adequate, reliable cold water supply from your tower . . . Directions for controlling pH of water, preventing algae with chlorine . . . How to maintain upspray, downspray, flume and open-pan distributing systems . . . Care of filling and basins . . . What to look for in mechanical equipment; how to fix it . . . Tower maintenance schedules

By JAMES G. DE FLON Chief Engineer
Manufacturing Division The Fluor Corp., Ltd.

COOLING TOWER maintenance, in the past, has not received sufficient attention from plant operators. In most plants there is a program of preventative maintenance for all operating equipment, and such a program should certainly be extended to include cooling towers. There is little doubt that the inaccessible location of most towers, either on a roof or on the outskirts of the plant, is responsible for this. Nevertheless an adequate supply of cold water is absolutely essential for satisfactory and efficient plant operation.

The very principles on which the cooling tower functions also give rise to the problems of maintaining it. For instance, in order to obtain desired cooling of circulating water, evaporation must take place, and this creates a new problem by increasing the salt content of the water.

To perform satisfactorily, cooling towers are usually installed in open, unobstructed areas where wind velocities are such as to allow dust, dirt and debris to be carried along. Since the air passes through the tower over which water is falling, the debris may be washed out of the air and into the basin, and another problem is created.

In order to keep the salt content of the water in the basin at an absolute minimum, and also to remove any collected dirt, dust, and other debris from the basin, it is recommended that a continuous blowdown be made a part of the cooling tower system, and that the tower be scheduled for periodic shut-downs, so that the internal filling of the tower and the basin can both be cleaned.

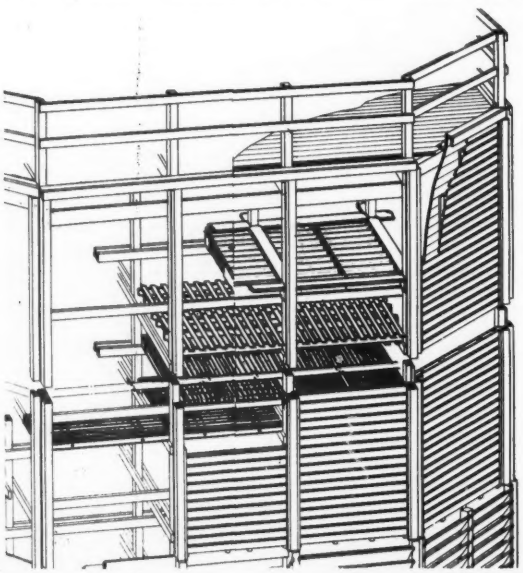


Fig. 2. Cut-away view of portion of cooling tower, showing wall and filler details

Water Treatment

Maintenance of a cooling tower, exclusive of any mechanical equipment, is closely associated with the quality of the water used. Water treatment is an entire field in itself, but the following is the general opinion of a number of plant operators. It is not intended to be a solution to a specific water treatment problem, but is to be used only as a guide. For specific problems, companies specializing in water treatment should be contacted.

Briefly, however, water treatment is used to control algae, to control scale formation, and to prevent deterioration of the materials used in the construction of the equipment.

Many operators have found chlorine to be one of the most suitable agents for the control of algae. In many plants, satisfactory algae control is obtained by injecting 6 to 8 lb of chlorine per day for each 1,000 gpm circulated. If this is consistently added to the water, however, a type of algae immune to chlorine will soon develop. Therefore, every 10 days or so, for a short period, the amount of chlorine supplied to the system should be increased several times, thus preventing this chlorine-immune algae from developing.

Generally speaking, by controlling the pH of the cooling tower water, it is possible to control the rate of scale deposition in piping and on exchanger tubes. The higher the pH of the water, the greater the tendency for a scale to deposit. When the pH is below 7, little or no scale deposits; rather, the metals in contact with the water slowly begin to dissolve. The latest, most satisfactory, practice is to keep the pH of the water between 6.5 and 7, and then add a corrosion inhibitor to the system. This keeps the piping and exchanger tubes clean, and pre-

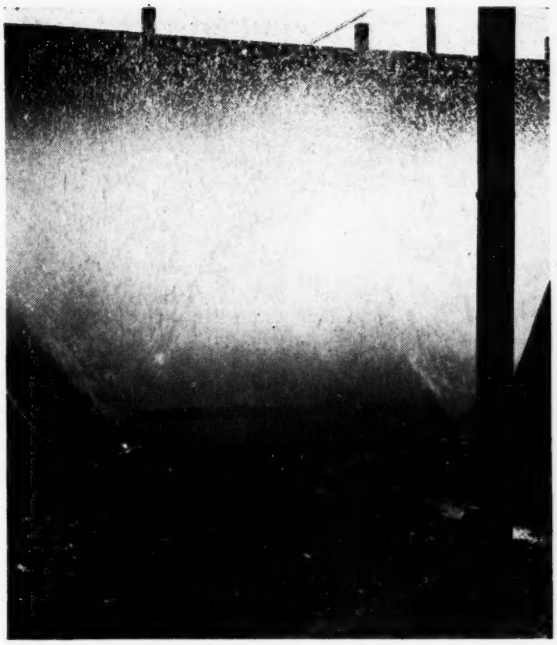


Fig. 3. View in test tower, showing operation of spirodome nozzles used in counterflow (induced-draft) cooling towers

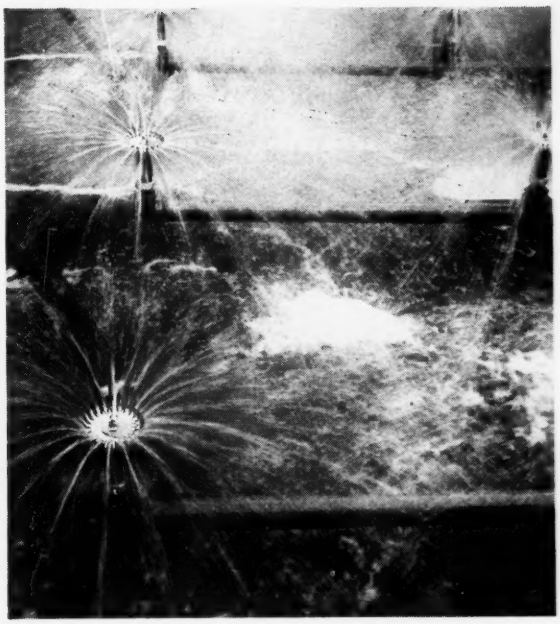


Fig. 4. View in test tower showing operation of low-pressure stainless steel nozzles

vents the metal from corroding. However, the above treatment should be attempted only under the advice of a water treating specialist.

In certain areas of the Western United States, the water tends to be very alkaline because of the presence of sodium, calcium, and magnesium salts, occurring in the form of bicarbonates. This situation is further aggravated as the cooling tower tends to concentrate the salts in the system. It has been found that when the pH of the water is over 9.0, and when large amounts of bicarbonates are present, the structure of the wood in the cooling tower may be seriously affected.

It is particularly noticeable where the wood is alternately wet and dry, a condition that occurs on the sides of an atmospheric tower. At these points the bicarbonates concentrate, and turn into normal carbonates. The carbonates attack and dissolve the lignin in the wood, producing an effect termed delignification. This is evidenced by a soft spongy, stringy wood structure, which appears to be decayed. The only way delignification can be absolutely prevented is to remove the bicarbonates from the circulatory system. This is impractical in many cases. However, plant operators report delignification can be controlled by keeping the pH of the water below 8.5.

Once the importance of the water problem is understood, the operator should next consider the scheduling of a regular inspection and maintenance program for his cooling equipment. This regular inspection program should include the distributing system, filling, outside covering (paneling, louvers or aerators and drip panels), framework, basin, drift eliminators, coilshed sections and mechanical equipment.

Distributing System

Importance of maintaining the distributing system at peak efficiency cannot be over-emphasized. The function of the distributing system, is to distribute the water uniformly over the top of the tower, and to break it up into fine particles in order to expose as much water surface as possible to the air.

Four general types of distributing systems are in common use today; namely, the upspray, the downspray, the flume systems and pan-type systems. However, before discussing the specific types of systems, it is well to point out that, regardless

MINIMUM MAINTENANCE SCHEDULE FOR AN ATMOSPHERIC TOWER

ONCE PER WEEK

Inspect suction pit screens and clean as required.

ONCE PER MONTH

Inspect flume type distributing systems and clean as required.

ONCE EVERY THREE MONTHS

Inspect and clean downspray distributing system.

ONCE EVERY SIX MONTHS

Inspect and clean upspray distributing system.

ONCE PER YEAR

Shut down tower and thoroughly clean, particularly the distributing system, filling and basin. A thorough inspection of the structure together with the filling, louvers and Aerators should be made at this time. Any repairs required should be made immediately. Should the tower contain a flume type distributing system, it should be releveled and also repaired as required.

MINIMUM MAINTENANCE SCHEDULE FOR A MECHANICAL DRAFT TOWER

ONCE PER WEEK

Inspect suction pit screens and clean as required.

ONCE PER MONTH

1. Check oil in gear case for level and contamination.
2. Lubricate universal joint type couplings.
3. Inspect and clean flume type distributing systems.

ONCE EVERY THREE MONTHS

1. Check downspray distributing system and clean if necessary.
2. Inspect disk type couplings for fractures in disks.

ONCE EVERY SIX MONTHS

1. Drain and refill gear case with recommended oil.
2. Lubricate motor bearings.
3. Check upspray distributing systems.

ONCE PER YEAR

The tower should be shut down and thoroughly cleaned from top to bottom, including the basin. A thorough inspection of the structure should be made, together with the necessary repairs and replacements. Should the tower contain a flume type distributing system, it should be releveled and repaired at this time. The mechanical equipment should be checked for alignment and the bolts anchoring this equipment should be tightened. The fans should be inspected and repaired as required. The gear type couplings should be opened up for inspection and serviced and the gear box bearings and seals examined for wear.

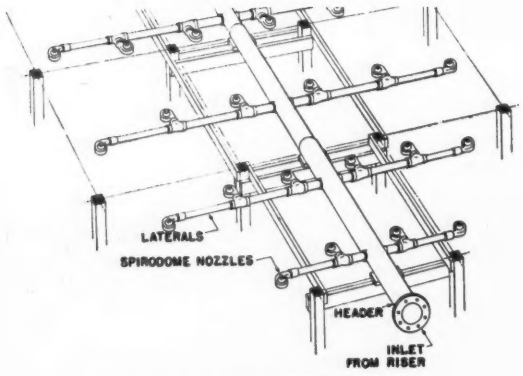


Fig. 5. Typical upspray distribution system

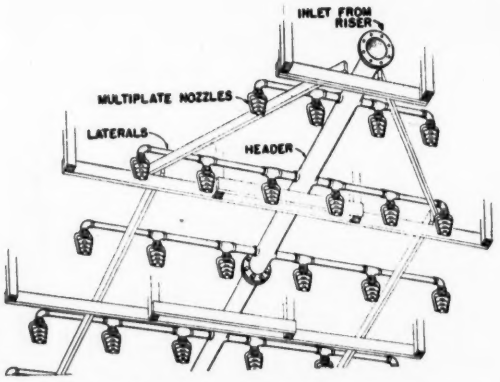


Fig. 6. Typical downspray distributing system

of the type of system employed on new towers, it will be necessary to inspect the nozzles every week or two for the first three months of operation—that is, to make sure that any wood splinters, shavings or other debris normally found in a new tower have not plugged some of the nozzles.

Upspray System:—The upspray system consists of a central header with pipe sidearms to which, at regular intervals, are attached the upspray nozzles. This system ordinarily operates at 5 to 6 psi nozzle pressure, and depends on centrifugal force, rather than small orifices, for fine breakup of the water. The nozzle orifices are usually about 1 in. in diameter. This large opening, together with 5 or 6 lb pressure drop, is sufficient to prevent algae, small rocks and sand from plugging the nozzles.

The system is usually located about 6 or 8 ft below the drift eliminators on mechanical draft towers, and about the same distance from the top of an atmospheric tower. The nozzles spray up and completely fill the spray chamber with finely divided water. This system will distribute the water uniformly with a wide variation of water flow. It requires a minimum of attention, but should be inspected every 9 to 12 months and any obstructions in the nozzle should be removed. This inspection, of course, is predicated upon the fact that the user inspects the system as mentioned above during the first two or three months of operation.

Downspray System:—This consists of a central header with pipe sidearms, to which, at regular intervals, are attached downspray nozzles. This system is usually located as close to the top of the tower as possible and operates on about 1½ lb nozzle pressure. Because of the low pressure, the nozzle must operate on the principle that water impinging on a plate will be distributed evenly. This system perhaps will not keep itself quite as clean as the upspray system; however, it too will uniformly distribute water with a wide variation of water flow. This system should also be inspected every three to six months.

Flume Type System:—This is composed of a main flume extending around the outside of the cell with inter-connecting flumes. The flume is usually constructed of wood. In its bottom, holes are usually bored, into which are inserted plastic discharge tubes. Two to three feet directly below each discharge tube is a plastic splash plate upon which the discharge stream from the flume impinges. The effect of the stream of water falling on this plate causes a splashing action, which distributes the water.

This type of system is not as flexible as the two types previously described. At high water rates, the flumes overflow; and at reduced rates, the water is not uniformly distributed. This type of system presents a continual maintenance problem. Because the flumes tend to open up at the seams, they require leveling, and the splash plates have to be renewed periodically, and adjusted so that the stream of water impinges directly on the center of the disc.

Flumes form an ideal place for sludge, algae and sand to accumulate, therefore they require frequent cleaning. Also, since the algae growth varies with the water temperature, the open flumes offer an ideal place for its growth. This type of system should be inspected every thirty days and repairs made immediately. If allowed to get into a state of disrepair, the performance of the tower will be seriously affected, and the cost of making the repairs will be increased.

Open Pan Type:—Another type of flume system is the open pan type, which covers the effective part of the cooling tower. In this type a large number of small nozzles, operating at an extremely low water head, are used. These become plugged easily with small pieces of debris. This type of system is susceptible to increased algae growth, due to the hot water temperature, and to its exposure to direct sunlight. By placing a cover over the distributing system, much of the debris blown in by the wind can be eliminated. This will also retard algae growth, since it shields the water from direct contact with sunlight. If covers are provided for the system, inspection should be made every two to three months;

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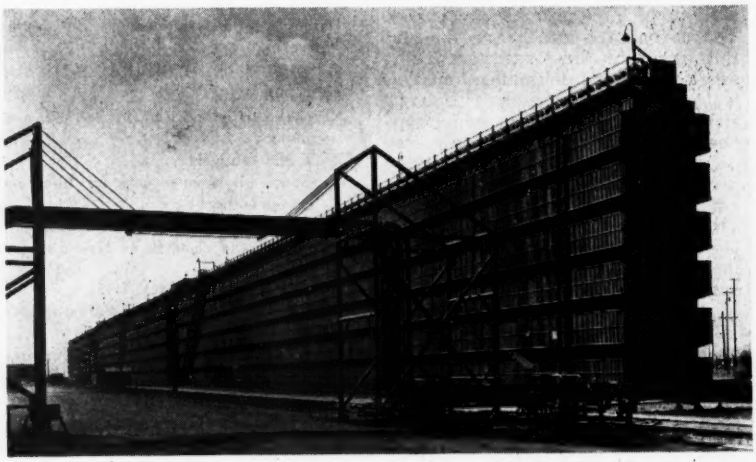


Fig. 7. View of large cooling tower installation

LIGHTNING WATCHING — A Full Time Job

PROBABLY the most unusual summer job a college boy ever had was the "lightning watching" assignment last summer of John Alger, 20-year-old Massachusetts Institute of Technology electrical engineering student.

In charge of the sensitive lightning recording equipment which General Electric Co. lightning scientists installed for the eighth summer atop the Empire State Building, Alger was on the alert for storms 24 hours a day, seven days a week.

Actually, the Empire State Building, where Alger had his recording devices, plus the 50-ft high National Broadcasting Co. television and FM antenna atop the building, is a "lightning rod" for the buildings within a one-third mile radius of the tall building. The steel-structured frame of the building provides an easy path to ground for electric charges forming in the area, protecting everything in the Empire State Building itself and the surrounding buildings.

Alger was so conscious of his job that the rumble of a New York Subway train beneath his hotel window caused him several times to leap from bed and look at the sky.

Several days would go by with no suggestion of storms, then he found himself with extra time after his routine of checking equipment, adjusting cameras.

Alger was working on lightning research on a co-operative program between the General Electric Co. and MIT and gets academic credit toward his degree, which he will receive next February. His summer job was completed on October 1.

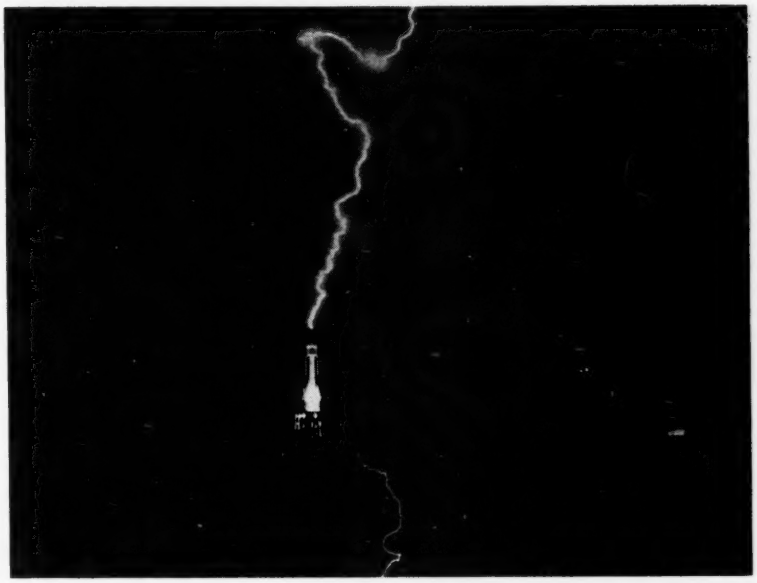


Fig. 1 (Above) Lightning striking the Empire State Building. New York's tallest building, actually, is a lightning rod for the buildings within a third mile radius. The steel frame of the building provides an easy path to ground for electric charges forming in the surrounding area

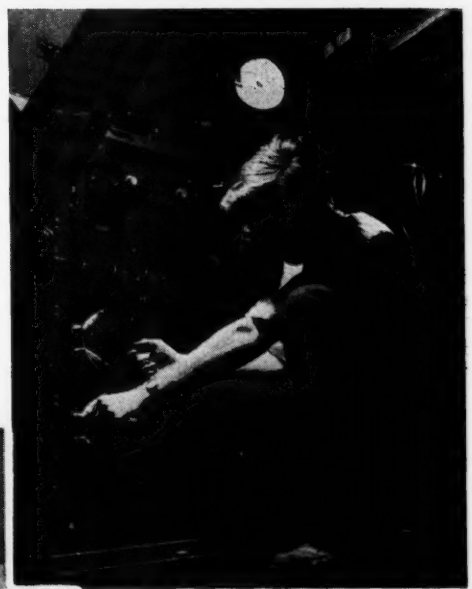


Fig. 2 (Above) Alger at the oscillographs in the Empire State Building

Fig. 3 (Left) Alger at the camera location at 521 Fifth Avenue. At this station he kept a camera trained on the tall building to photograph flashes whenever they occurred

Fig. 1. Result of an explosion in a direct expansion milk cooler of 12,000 lb capacity per run. Rupture took place inward, and from the bottom upward

How to Analyze Causes of Ammonia System Explosions

By GEORGE HOLMAN
Refrigeration Service Engineer, Anderson & Kohler, Decatur, Ill.

EVERYONE DEALING in any way with ammonia as a refrigerant knows that it is a strongly odorous, breath-taking and injurious volatile kept in a steel and iron circuit strongly built to hold it under the high pressure of the vapor it evolves. Every pipefitter who has ever made up a threaded pipe joint of an ammonia refrigeration system knows how hard it is to make the joint ammonia-tight. Every service mechanic who has ever packed the stem of an ammonia valve knows it. And every refrigeration plant engineer who has ever pumped down an ammonia system knows it—and should also know the more important characteristics which make ammonia the dangerous refrigerant it is.

Every text-book of refrigeration, every manual of ammonia plant operation and every journal publishing data on ammonia refrigeration systems stress the need of caution in the handling of ammonia. There is no end to the sources of information on this toxic and dangerous refrigerant. Yet year after year ammonia plant explosions continue to occur. Working schedules are interrupted and workmen injured, asphyxiated, or killed. Goods are spoiled and costly equipment damaged—all because someone did not know that an ammonia system would explode.

While each ammonia refrigeration system contains one or more compressors, one or more condensers, one or more expansion valves and one or more evaporators, with necessary connecting pipes, each has peculiarities common to itself in design, equipment, condition and method of operation. Explosions occurring in ammonia systems therefore differ from one another in many ways. Before attempting to analyze the causes of any explosion, a clear concept of the conditions which make any explosion possible, if not probable, should be established.

There are a number of factors which govern the setting up of an explosive condition in an ammonia refrigeration system. These fall into two common classes: A. Conditions of the system; and B. Conditions of the charge it contains.

(A) System Conditions

One or more of several system conditions may share in the responsibility for an ammonia system explosion. Very important are:

1. The system may be designed too weak for slightly higher than normal pressure. A weakness needs be at only one critical part of the system to cause an explosion, and not necessarily at the point where rupture later occurs. The weakness may be at a point external to the system proper. For example, an evaporator hanger may be too flimsy, and by yielding at one point cause the system to rupture at some point distant from the basic cause.
2. The system may have been faultily installed. For example, the system may require a 1 in. safety valve. Yet during erection its future action may be restricted by pipe smaller than 1 in. installed between it and the pressure vessel it protects, or between it and the atmosphere, or vessel, into which it discharges.

Sometimes through ignorance of common safety precautions a stop valve is placed between the system and the safety valve. The excuse generally given is "so that the safety valve can be taken off and repaired, should it leak." Later, this stop valve may be closed because the safety valve does leak, and repair postponed. This writer has found stop valves so installed, and has also found safety valves (?) with plugs screwed into the outlets.

It cannot be stressed too strongly that the pipe leading to a safety valve must be no smaller than the valve inlet, and that any pipe leading from it must be short and no smaller than the valve outlet. Both must be free of other valves, or any obstruction whatever.

3. Wrong materials may have been

used in system construction or repair. To this writer's knowledge, the use of annealed cast iron pipe fittings is the only common instance of this. At one time, cast iron fittings were used universally. Many installations using cast iron have given trouble-free service for 30 or 40 years. But such installations cannot be as safe as those using steel or malleable cast fittings. Cast iron will break under impact, and a cast iron fitting may burst if the pipe is screwed in too tight.

4. Wreckage similar to, and often accompanied by, an explosion by failure of a compressor part under normal or abnormal conditions.
5. There may be unsuspected flaws in the system equipment, either in welds or in the parent metal.
6. The system layout or part of its equipment may be wrong for the type of service required. For example, a flooded evaporator may be used in a plant where a frequent pumpdown is necessary. In such cases a residue of liquid ammonia may be locked off in the evaporator by stop valves after a too short pumpdown. By application of heat, or merely by exposure to ambient temperature, this confined liquid may build up an explosive pressure.

(B) Conditions of Charge

This brings us to the second division of the causes of ammonia system explosions, the conditions inside the pipes and vessels at the time the explosion occurs, and from which the terrific force of the explosion is derived. These conditions are complex. Yet every plant engineer should have a clear knowledge of them and of how they change in the presence of heat.

The following substances and combinations of substances may exist at any time within a section of an ammonia refrigeration system, especially during a pumpdown or when making repairs:

1. Air only.
2. Air and NH_3 vapor.
3. Air and oil.
4. Air, oil and vapor.
5. Air, vapor and liquid.
6. Air, oil, vapor and liquid.
7. Vapor only.
8. Vapor and liquid.
9. Vapor and oil.
10. Vapor, oil and liquid.
11. Oil only.
12. Oil and liquid.
13. Liquid only.

There are small quantities of other substances, such as water and hydrocarbon gases evolved in the breakdown of lubrication oil under the heat of compression. The latter may be important in a high side explosion, or when making a weld in any part of the system. When isolating a section of the system for repairs or inspection, and especially if welding is to be used, all possible combinations of the above-listed substances should be considered.

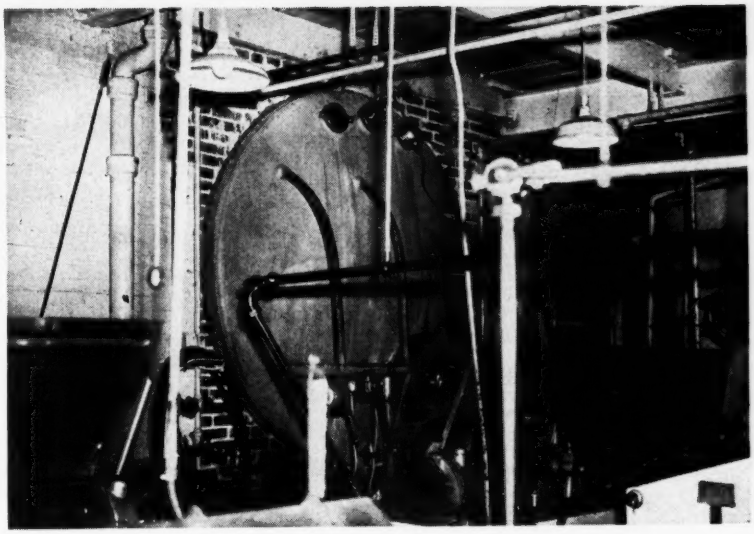


Fig. 2. A view of the milk cooler before the explosion wrecked it

1. AIR ONLY.

As a cause of a major explosion, air only needs to be considered only when placing the system under air pressure for testing.

2. AIR AND AMMONIA VAPOR.

Because each exerts its own separate pressure against the system walls, and the total pressure is the sum of their separate pressures, the presence of this mixture in any system may cause or contribute to an explosion.

3. AIR AND OIL.

Air and oil in an ammonia system are just as explosive as air and oil in the cylinder of a Diesel engine. Only heat at a high temperature is required to set it off. This heat may be derived from an external source, or from the heat of compression.

4. AIR, OIL AND VAPOR.

If ammonia vapor is present in an air-oil mixture, it may be dissociated by heat, and its hydrogen component recombined with oxygen to add force to an explosion.

5. AIR, VAPOR AND LIQUID.

Liquid ammonia adds force to an explosion by combining with the heat evolved, and giving off a vapor which exerts a pressure corresponding to its temperature.

6. AIR, OIL, VAPOR AND LIQUID.

This is the most dangerous of all mixtures to be found in a refrigeration system, and always exists, during normal operation, on the high pressure side of the system. There all air in the system collects. In dry expansion systems most of the liquid ammonia collects there. There most of the oil collects. And there too, the temperature is always the highest.

(Continued on page 124)

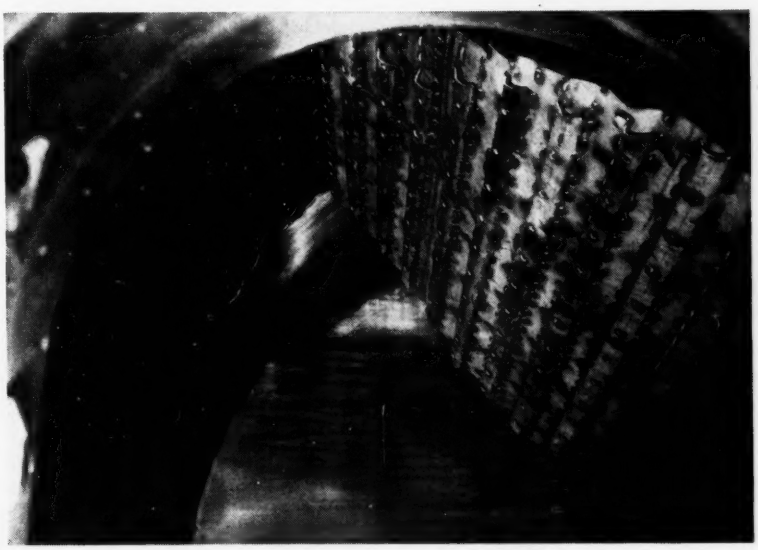


Fig. 3. Another view of the results of the explosion

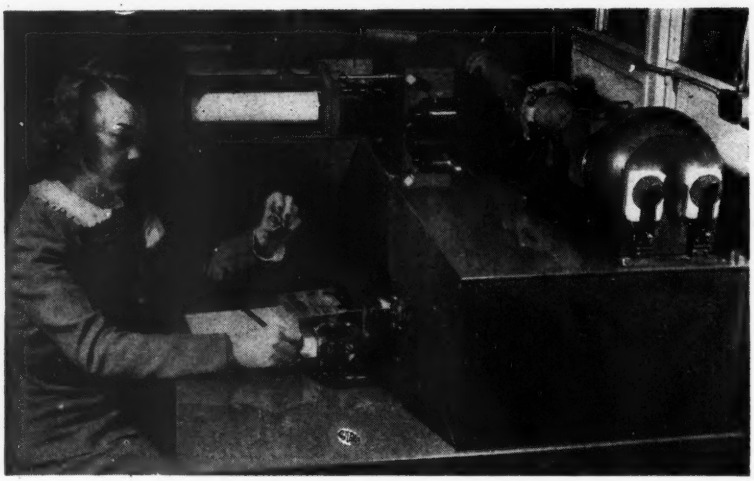


Fig. 1. The Spectrophotometer automatically draws the curve while the operator prepares the next sample

Making Special Measurements

In many industrial organizations it is necessary to make special measurements of unusual quantities both in production processes and in maintenance of mechanical and electrical equipment. Often a special instrument engineer is provided for making such measurements but in smaller organization the job is up to the mechanical or electrical engineer. In any case, these measurements have to be made and they often require ingenuity as well as knowledge of special equipment. In this article the author describes a number of these measurements. They should be of more than passing interest to every engineer

By H. JOHNSTON Special Products Division, General Electric Company, Schenectady, N. Y.

THE UNUSUAL quantities to be measured in power and industrial operations have often taxed the ingenuity of the instrument engineer. Usually, he has come through with flying colors. For example, he has made it possible for us to measure such things as color, hardness, roughness, strain, vibration, puncture strength, speed, torque, viscosity, and many other quantities, including the presence of a hole so small that the passage through it of one quart of air would require 15,000 yr.

The measurement of color is perhaps one of the most difficult to accomplish. This is true since it must be done with considerable accuracy because of the extreme sensitivity of the human eye to color differences. Color measurement is quite essential, however, because of the variation between the judgment of different humans on even a simple subject like color. The recording spectro-photometer shown in Fig. 1 is a color analyzer which automatically plots a curve which shows the amount of light reflected or transmitted by the sample plotted against the wave length of light. This instrument is extremely valuable in maintaining permanent, accurate color standards. By having a permanent standard, and with the ability to measure the color of the products being manufactured, close control can be maintained over the quality of the final product.

The spectrophotometer measures color by comparing the amount of light reflected by the sample with the amount of the same color light reflected by a standard white. This comparison is made 60 times per second, so that a practically continuous check with the standard is maintained. Any difference between the light transmitted or reflected by the sample and that reflected from the standard is used to adjust the optical system to bring these two values into balance. The measurement is always made at this balance point, so that considerable accuracy is obtained. The instrument automatically scans the complete visible spectrum from wave lengths of 400 millimicrons to 700 millimicrons and on into the near infra-red to 1000 millimicrons if desired. As this spectrum is scanned, the recorder chart is moved so that the pen which moves in accordance with the amount of light reflected plots a curve showing light reflectance versus wave length. This curve is a complete and accurate description of the color of the sample.

Carpet manufacturers are using this equipment to test the color of materials used in rugs and carpets. One chemical company uses nine such instruments for keeping close control over the chemical compositions of their process. It is widely used for standardizing and maintaining the color of batches of pigments for inks and dyes. In addition, textile companies are using it in finishing processes for continually monitoring the output for the finishing process so that a constant color can be maintained.

Another quantity which is important to quality is thickness. Simple thickness gages such as that shown in Fig. 2 have been devised to give a quick indication of the thickness of the non-magnetic coatings, such as paint on a magnetic material, like steel. Close control of paint thickness will prevent losses from too heavy a coat of paint or poor quality from too thin a coat. One manufacturer found the thickness gage to be very useful for matching colors. In making white enamel appli-

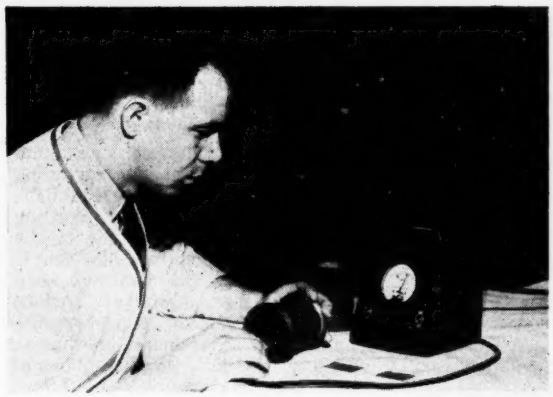


Fig. 2. (Above) Thickness gage used to check babbit in bearing liner

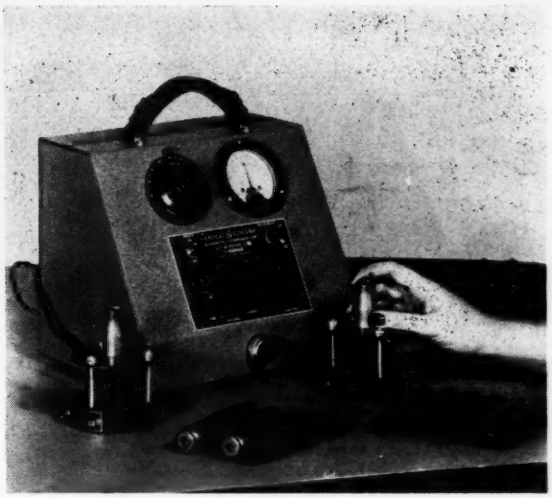


Fig. 3. (Right) Magnetic comparator checks hardness of shell casing

ances which consisted of several parts, he found that the thickness of white enamel determined the shade of white which the part appeared. When two or three parts with different paint thicknesses were assembled, the colors did not match, and the resulting product did not have the "eye appeal" which results in sales. The solution was to measure the enamel thickness of the part as it came from the drying oven. Based on thickness measurements, the parts were all divided into four groups. When assembled, then, all the parts from one group would appear to be the same color. The use of this inexpensive gage has been saving this company an estimated $600 per month for several years.

This thickness gage is a simple impedance bridge in which the active arm of the bridge is the gage head. When this gage head is in contact with a magnetic material, its coil has a certain impedance. As an air gap is introduced between the gage head, and the magnetic material, the impedance of the coil changes, thus changing the balance of the bridge. A coat of enamel, for example, on steel will form the "air gap" and change the bridge balance. The indicating instrument can then be calibrated in thousandths of an inch and will accurately measure the thickness of the paint when it is as little as 0.0001 in. up to as much as 0.1 in.

This gage has been quite successfully used for measuring the amount of babbitt present in a bearing lining, or the amount of plating on a steel part. It can also be successfully used for measuring the thickness of sheet materials such as plastics or mica. For this use, the sheet material is placed on a steel block and the gage head is placed on top of the materials, so that the thickness of material to be measured again forms the air gap in the magnetic circuit of the gage head, thus changing the impedance of the active arm of the measuring bridge.

Another item of considerable interest to plant management is preventive maintenance. Periodic inspections of plant equipment are felt to be quite essential, but visual inspection alone may not be sufficient to warrant the expense involved. Visual inspection, combined with the measurement of several pertinent quantities, very often detects trouble before it actually develops

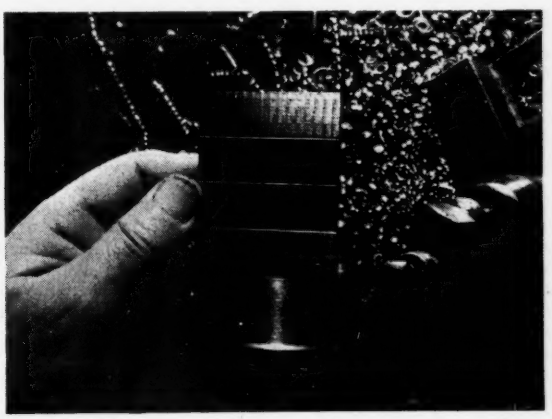


Fig 4. (Above) Close-up of one of the eight-block set of G-E standard roughness specimens being used to check a metal surface during machining

Fig. 5. (Left) Operator making a test weld with current force recorder in place

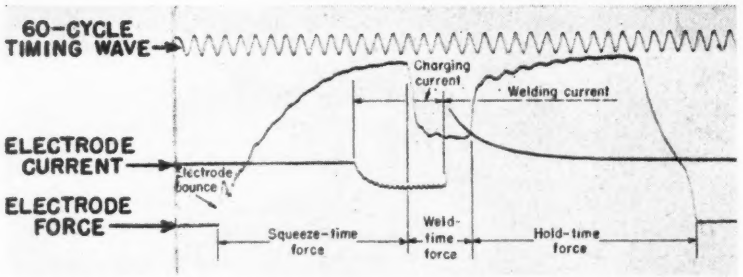


Fig. 6. An oscillograph (reduced to approximately 50 per cent of actual size) obtained with current-force recorder

into a serious problem. With rotating electrical equipment, for example, the periodic measurement of vibration with a light beam vibration indicator is an easy task. The record of vibration amplitude when compared with past periodic readings will quickly tell whether some overload or surge condition has shifted the mass of the rotating parts to cause unbalance, which will damage the machine unless "first aid" is given promptly.

This accurate vibration measuring instrument is equally useful for testing new equipment right off the assembly line. Such tests allow the engineer to detect excessive vibration and to correct it before the equipment leaves the factory. In this way, he insures continued quality of product and prevents later complaints.

The light beam vibration indicator consists of a small mirror which is oscillated by the vibrating motion of a stylus which contacts the equipment under test. A light from a small lamp is reflected by the mirror on to a ground glass scale. With the mirror oscillating, this spot of light becomes a line. The length of the line as measured on the scale determines the amplitude of vibration. Vibration amplitude of approximately 0.0002 in. up to about 0.03 in. can be measured.

Preventive Maintenance of Electrical Equipment

Preventive maintenance of electrical equipment includes insulation resistance measurements. These can readily be made with the electronic insulation resistance meter. Periodic measurements, if recorded to show past history, will indicate possible tendencies toward failure before actual failure occurs. This will allow repairs and maintenance at the convenience of operating personnel rather than under emergency breakdown conditions.

In designing this instrument, the instrument engineer has kept in mind the dark corners often encountered by the maintenance crew, and has provided a well illuminated dial. The instrument itself operates from 115 volts and requires no special skill on the part of the operator. It is particularly well adapted to making continuous insulation readings versus time, to determine what the insulation strength is and how it changes during the warm-up period.

Magnetic Comparator

One of the nightmares of the superintendent is the new employe who disarranges the stock in the stockroom, or thoughtlessly mixes the hardened pins with the soft ones. The magnetic comparator shown in Fig. 3 allows rapid separation of the "good" from the "bad", based upon their individual heat treatment, chemical composition, or hardness. This instrument compares the unknown with a standard part which is satisfactory. When one is magnetically balanced against the other, the indicating instrument shows how far off the unknown is, and when tolerances have been set up the unknown can be accepted or rejected. The magnetic comparator applies to magnetic materials, while the new metals comparator is suitable for most non-magnetic materials such as brass or aluminum. as well as the usual magnetic steels.

One manufacturer was suddenly faced with a failure of a vital part at the end of his assembly line. Tracing the part back, he found that the man assembling that vital part was working from a bin containing approximately one million parts. The failure indicated that the bin contained a mixture of unhardened parts with the usual hardened parts. Without the magnetic comparator it would have been necessary to reharden all the parts, but with the use of the magnetic comparator the "sheep" were separated from the "goats" in a few days.

The magnetic comparator is another form of impedance bridge. In this case, two arms of the bridge are made in the form of coils. In one of these is inserted the standard part which has been determined to be satisfactory. The unknown parts are then placed, one by one, into the other coil. If the unknown parts match the standard with respect to heat treatment, chemical composition, and hardness and general shape, the bridge will balance. Changes in any of these quantities may cause an unbalance. For comparing quantities of material, tolerances of balance must be set up. From then on the operation of the instrument is a routine one.

Surface Roughness

Another one of the problems found in every factory where machining is done is the difficulty of establishing a common language between the engineer, the draftsman, the machinist, and the inspector. A simple solution to this problem has been found for the quantity "surface roughness." Figure 4 shows the standard roughness specimens, which are actually small replicas of machined surfaces which the different members of the industrial team use to see and feel degrees of surface roughness. The engineer and draftsman can determine by "feel" that a certain rougher (and, therefore, less expensive) surface can be used. The machinist from his set of specimens knows immediately what the finish numbers mean, and can quickly compare his work with his set of specimens so that he doesn't over-machine or under-machine. The inspector, in turn, can also compare the finished part with his set of standards.

The standard roughness specimens are made as replicas of a set of masters. This insures similarity between sets. Engineering departments in different plants of the same company can, therefore, be assured that they are using the same roughness standards in specifying surface finish. A manufacturer can be sure that his sub-contractor in another city knows what the finished mark means without having to send an engineer to interpret. The use of actual finishes which can be seen and felt helps to settle many disagreements concerning the finish which has been machined into a part.

Current Force Recorder

Adjustments of machines are also important to good quality and high production. A spot welder, for example, must be adjusted so that the right amount of pressure is brought to bear on the work and so that the pressure is applied at the right times with respect to the welding current. The welding current itself must be adjusted to the proper value for the best results. The current force recorder shown in Fig. 5 gives a curve of electrode pressure and welding current for the capacitor discharge type of spot welding. The resulting curve (Fig. 6) shows whether adjustments should be made in either of the quantities to maintain good quality of the welded product. Periodic checks will prevent losses caused by poor welds which are detected in later tests.

The equipment consists of an electrode unit which is put into the welding machine in place of the usual electrode for the purpose of

these tests. An actual weld is made with the test electrode. A strain gage on the electrode detects the pressure while a shunt gives a measure of current. The strain gage signal is amplified and transmitted to the small oscillograph galvanometer. The three quantities of force, current, and time are recorded simultaneously on the oscillograph paper.

The test weld is then checked for quality, and when the welder has been properly adjusted to make good welds, a record is made of its adjustment. Periodic tests, which can be made quickly, will then show whether or not the adjustment of either current or pressure has changed. If not, the quality of the welds should remain good. If any change has occurred, comparison with the former record will indicate what adjustments should be made.

The current force recorder has been especially important in the spot welding of aluminum for use in aircraft parts, where it is important that every weld be a good one, and where a great many welds are used.

Machine Protection

Machine protection is important where large forces are involved. For example, in hydraulic presses or bending machines, it is essential that the machine parts should not be strained beyond endurance. Overloading of machines often results in failure and extended shutdowns. One manufacturer found that the rolls of a bending machine had to be replaced about once a month because the operator had no way of knowing when the capacity of the machine was being exceeded. The installation of a small magnetic strain gage (Fig. 7) warned the operator when the pressure was too great, and it was later set up to shut the machine down when the vital parts were overstressed. Needless to say, this installation paid for itself in the first month. It also paid for itself in worker good will, since it protected the operator from serious injury which might result from a machine failure.

The magnetic strain gage is especially adapted to continuous operation in industrial plants, since it is inherently a simple equipment requiring no amplifiers or special voltage control. It operates from 115 v and requires only a balancing unit and control box in addition to the indicating instrument or alarm relay. It has been widely used for laboratory and experimental tests for testing the strength of railroad bridges or measuring the lift of helicopter rotors as well as measuring strains in large structures.

Only a few years ago manufacturers of refrigerators had to depend on placing the refrigerating unit in the "bathtub" to see if it were leaking. By this method, large leaks are readily detected, but the very small ones escaped notice. The development of the mass spectrophotometer type leak detector has allowed the engineer to maintain better control of quality of refrigerating units, and to determine the sources of even the smallest leaks. This leak detector is very sensitive to helium—it will detect the presence of one part of helium in two-hundred thousand parts of air. Connection of the leak detector to the inside of a piping system or vacuum tube, and exposure of the outside to helium gas will give an indication of a leak small enough to permit the passage of 2×10^{-9} standard cc per second. Some bright engineer calculated this to be equivalent to about one quart in 15,000 years.

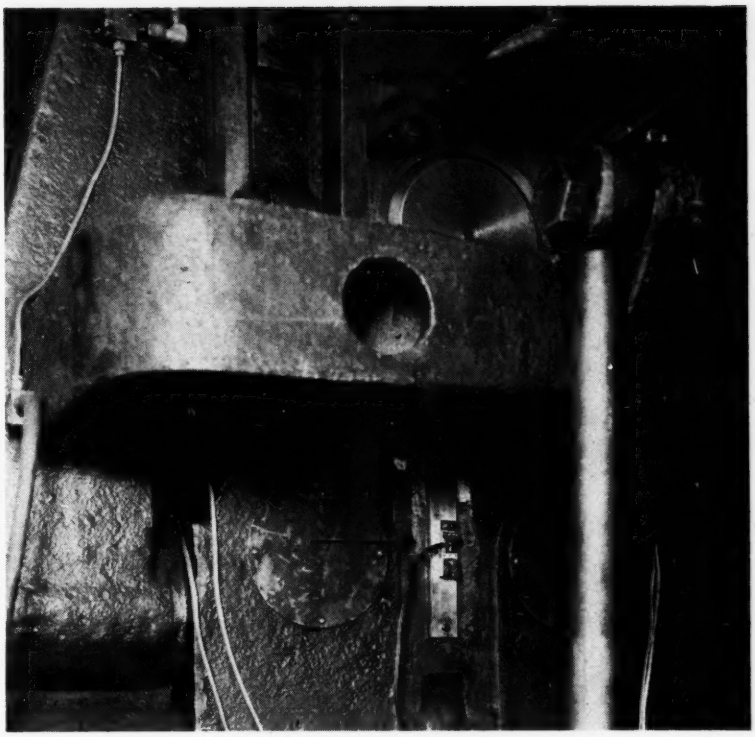


Fig. 7. Magnetic strain gage installed to protect roll bending machine

The spectrometer type leak detector is a very sensitive electronic equipment. It is a modification of the mass spectrograph which has been used for many years in studies of atomic and molecular weights and, as a spectrometer, has recently been more valuable for analyzing chemical components, especially in petroleum laboratories. This leak detector is a mass spectrometer designed for the low mass of helium gas. The ability to detect very small leaks has given the engineer a new tool in improving the quality of vacuum tubes, refrigerators, bellows, valves, and even chemical piping systems.

The instrument engineer carrying on with new laboratory developments is providing new tools constantly for plant management to use in adjusting machinery, protecting equipment, and maintaining quality and quantity on the production line. The measurements he has been able to make reassure us that we are far from reaching the end of man's ingenuity.

NEW POWER PLANT OF LEE PAPER COMPANY

(Continued from page 64)

located alongside the new 2500 kw turbine unit.

It will be noted from the plan that the plant includes a Diesel engine. This is an old 350 kw unit, provided for standby service, in case all the boilers are down.

On the whole, this is an excellent example of what can be done to modernize a small industrial power plant. All design and construction was carried out under the general direction and supervision of C. M. Daniels, the chief engineer and R. L. Hussey, chief electrician. Of particular interest is the lighting system, since this is one of the few power plants lighted entirely by fluorescent lamps.

These lamps are arranged in simple two lamp fixtures, as shown in some of the photographs and they provide excellent and ample illumination throughout all parts of the plant, including the boiler room.

The turbine room is served by a 7½ ton Shaw-Box crane.

New 1800-hp Radial Diesel for Heavy-Duty Stationary Service

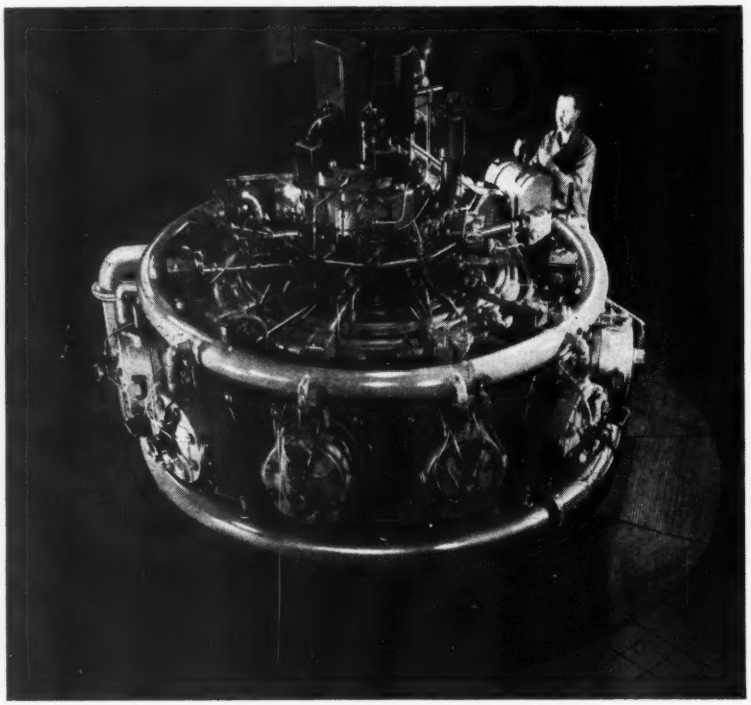


Fig. 1. General view of Nordberg radial engine installation, showing how entire engine and control, less scavenging blower and pumps, are above operating level, also illustrating relative size and compactness

HEAVY-DUTY 1800-hp radial Diesel engine recently announced by Nordberg Manufacturing Co., departs from conventional Diesel engine design in that it has cylinders arranged radially around a vertical cast iron crankshaft. This engine may be built to operate as an oil-burning Diesel engine, as a Duafuel engine, or as a spark-fired gas engine.

It is designed for a high degree of balance, to virtually eliminate vibration and to make possible its mounting on a simple and inexpensive foundation. Compactness of design results in relatively small space requirements, minimum weight and pleasing appearance. Even with direct connection to a generator, which is mounted to the lower end of the crankshaft, the Nordberg Radial Engine requires less than 18 ft headroom from the foundation and but a little more than 12 ft lateral space. Unit weight per horsepower of the engine is only about 39 lb.

Two-Cycle Engine with 11 Cylinders

The engine is a two-cycle type with 11 cylinders of 14-in. bore and 16-in. stroke. At its normal operating speed of 400 rpm it develops 1800 bhp at full load, or a net capacity of 1150 kw, after deducting approximately 100 kw for operation of the scavenging blower motor, which is directly connected to the generator leads. Intake and exhaust valves are eliminated by the timed uncovering, by pistons, of ports in the cylinder walls for intake of air and discharge of exhaust.

The crankcase is of rigid one-piece cast-iron construction with ribbed reinforcing. The single crank two-piece type crankshaft, made of special high-tensile cast iron, with integral thrust collar, is set vertically in the engine. The 11 cylinders are made from special cast iron and contain the water jackets and intake and exhaust ports. They are radially arranged and bolted to the frame in a horizontal plane. The crankcase has a central hub, which carries a main bearing bushing and thrust

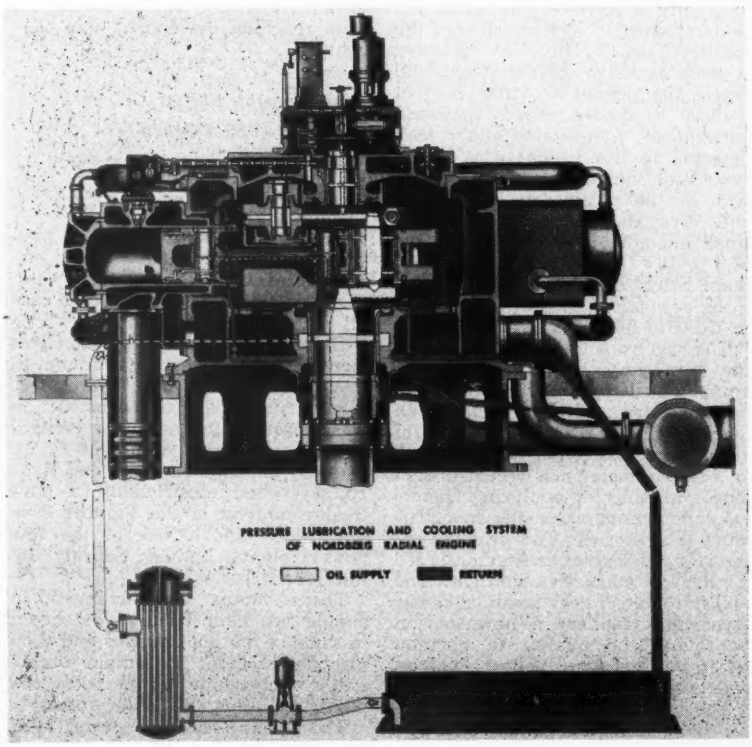
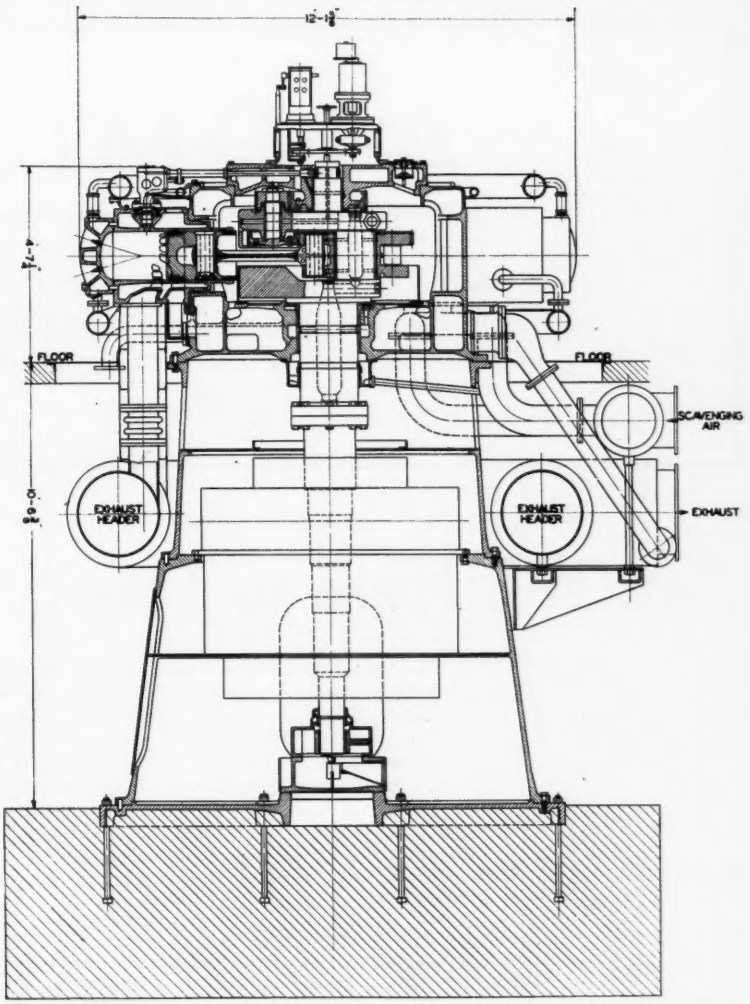


Fig. 2. Phantom cut-away view of pressure lubrication and cooling system for Nordberg radial engine

Fig. 3. Cross-section of radial engine. Generator mounted below engine crankshaft



bearing that supports the load of the crankshaft and generator rotor. One additional bushing fitted to the cover of engine forms the only other main bearing.

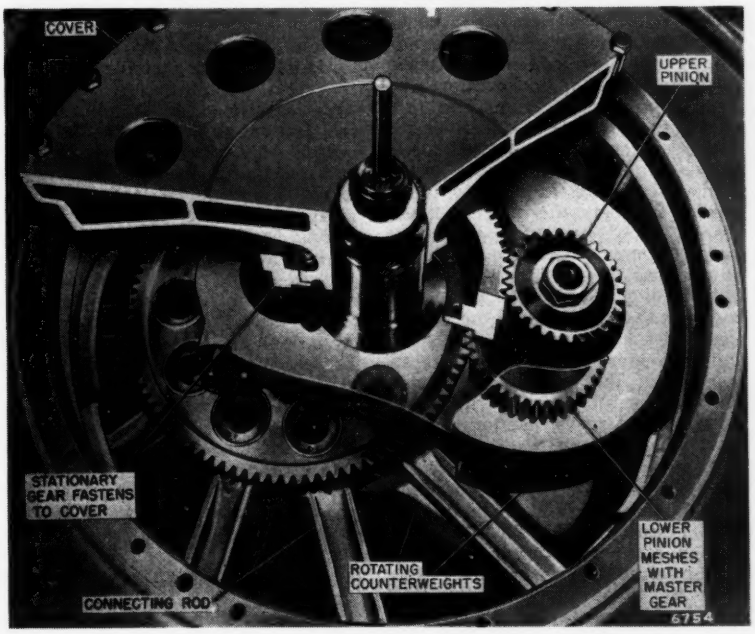
Mounted on the cover are the governor, fuel pumps, mechanisms for oil or gas operation and controls. Circular manifolds for scavenging and exhausts are located below the platform, or floor.

Unusual Connecting Rod Connections

An unusual patented feature of the engine is the method of attaching the connecting rods to the crankpin. Each rod is, in effect, a master rod. The 11 rods are each attached to a master gear assembly at regularly spaced intervals by knuckle pins riding in bronze bushings. The master gear assembly is fitted with a bronze babbitt-lined bushing forming the crankpin bearing. This master gear assembly is restrained from rotating by pinion gears meshing with the master gear and with a stationary gear attached to the top frame cover.

The master gear does not rotate around the crankpin but it has a gyratory action, which causes the pinions to "walk" around it. The relation of the various parts that is maintained by the gearing is designed to assure the optimum position of the master gear and counterweights for the absorption of piston thrust and balance of forces.

Two lubricating systems are provided. A multi-feed motor-driven lubricator supplies oil to the upper end of the cylinders at two points on the periphery of the cylinders. The bearing lubrication system is of the pressure-feed type, which circulates oil to all other parts of the engine. Both webs of the crankshaft are drilled and cored to conduct lubricating oil to the crank pin, knuckle pin, wrist pins and to the oil-cooled pistons through a large drilled passageway in each connecting rod. Oil from bearings and pistons returns to the engine sump from which it is pumped through a cooler and returned to the engine system.



When the Nordberg radial engine is used as a spark-fired gas engine, special heads are used to provide a compression pressure of about half of that used for Diesel or Dual-fuel operation. A patented system of spark ignition is used. All parts of the engine are designed to be readily accessible for inspection and servicing. In this engine all pistons, heads, liners, gas valves, and the like are made to be interchangeable.

The Nordberg radial engine has been in service for over 18 months. These engines are in full production and 80 are being built for the new Texas plant of the Aluminum Co. of America.

Fig. 4. Cut-away view showing piston action through connecting rods connected to master gear assembly

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Are WE Here to Stay?

The sheer horror of an atomic war will not necessarily result in the outlawing of atomic weapons or wars. As pointed out in this article the U.S. Atomic Energy Commission is inevitably committed to the development of atomic weapons but it so happens that scientific advances which help the development of weapons also advance the peacetime use of atomic energy. Perhaps in the development of unlimited power from atomic energy we may remove one of the major causes of war. New atomic power reactor to be built near Schenectady an encouraging sign

By **ANDREW W. KRAMER**, Editor, Power Generation

WHEN DR. J. ROBERT OPPENHEIMER was installed as the Director of the Institute for Advanced Study at Princeton a great many distinguished persons gathered to do him honor, among them, Dr. Einstein. At the ensuing reception many of the guests took advantage of the opportunity to speak to him and to ask his opinion regarding various aspects of atomic energy. Among them was a lady who gushingly asked ,"Oh, Dr. Einstein, do you think atomic energy is here to stay?" "That, Madam, is not the question," replied the learned doctor. "The question is, are we?"

Knowing Dr. Einstein's views on atomic energy his answer was more serious, probably, than those who overheard him might have supposed. For despite the glib way the subject of atomic energy has been discussed at the United Nations proceedings and the smug attitude of the military regarding our own atomic development, scientists who have the insight into fundamental matters that Dr. Einstein has, know that in the phenomenon of nuclear fission we have a force so terrible that it could, indeed, bring on the twilight if not the end of our civilization. Let there be no mistake about our awfulest conception of this new force —we may use words such as terrible, awful, frightful in alluding to it, yet our strongest emphasis can only be an understatement of this most terrific thing yet known to man.

Our Growing Stockpile

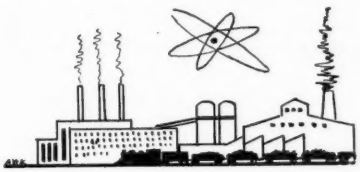
In America, many who read brief reports in newspapers and magazines of our progress in the manufacture and development of atomic weapons no doubt find comfort and satisfaction in the knowledge that we are so far ahead of other nations in the development of this new force. In this respect, atomic energy is regarded somewhat as statistics concerning numbers of aircraft or naval vessels. Few ever stop to realize that in atomic war there would be no security of any kind, regardless of how big a stockpile of atomic bombs we might have. If the enemy also had a stockpile of such bombs, and one must assume that in an atomic war the enemy would have such a stockpile, our own bombs would afford no protection against those of the enemy.

What is said here is not intended as a criticism of our own government's handling of the atomic energy question. We did issue the Baruch plan for international control of atomic energy and offered to abide by its terms. In the absence of general acceptance of this plan among the world's nations, we have no alternative but to continue to make and develop atomic weapons.

That fact, however, does not change the overall picture—a picture grim and foreboding. We have no right to assume that the very awfulness of the new force will compel us to do away with war. History affords us no such precedent. A Century and a half ago, a very wise American stood on the grounds of the Palace at Versailles and witnessed the birth of aviation—the sending up of the first hydrogen-filled balloon. The American observer, himself a scientist, was, of course, Dr. Benjamin Franklin. Naturally, he was tremendously impressed by the experiment and hurrying back to his lodgings he wrote to his friend, Dr. Jan Ingenhouz, physician to the Empress Maria Theresa of Vienna.

Fortunately, his letter has been preserved for us. He wrote, "It appears to be a discovery of tremendous importance." And he added, "It may give a new turn to human affairs. Convincing sovereigns of the folly of wars will perhaps be one of the effects of it since it will be impractical any longer for the most potent of them to guard his dominions." Only we, who witnessed the aerial destruction of European cities

during the last war know how very wrong Franklin was. It behooves us not to be similarly misled. Unfortunately, intellect and good will are not sufficiently distributed to have convinced all sovereign governments of the "folly of wars". As a consequence there is no other course for us but to prepare ourselves against the unpredictable future while continuing to hope that all sovereign governments will eventually become as open minded as our own. In default of that the world may have but



little opportunity to explore the inviting vistas now open to science or to enjoy the applications of research which promise such great benefits to men.

The question has been raised as to whether scientists acted wisely in presenting a problem of such magnitude and apparent insolubility to the statesmen of the world. Of course, they had no option, for as Dr. Fermi has said, "Once basic knowledge is acquired, any attempt at preventing its fruition would be as futile as hoping to stop the earth from revolving around the sun. And we know, too, that during the course of the war it was prudent to assume that we were in a race against time to develop an atomic explosive before that goal was reached by our enemies."

Purpose of U.S. Atomic Energy Commission

As pointed out in other articles in this section, the U.S. Atomic Energy Commission is concerned with the use and development of atomic energy for peaceful purposes but the fact remains that under the provisions of the Atomic Energy Act of 1946 it is declared to be the policy of the people of the United States that the development and utilization of atomic energy for improving the public welfare and increasing the standard of living shall be "subject at all times to the paramount objective of assuring the common defense and security." The result of this, in the world as we find it today, is that the major preoccupation of the committee of necessity should be, and is, the active development and production of atomic weapons. It is fortunate, however, that in the fundamental science as well as the technology connected with nearly every phase of the work on military applications of atomic energy, the peaceful arts are simultaneously advanced.

Also, at the present time, both the air forces and the navy are vitally interested in atomic power development from the standpoint of aircraft and ship propulsion and apparently have been able to put considerable pressure on the Commission to sponsor atomic power projects. The work under way at Brookhaven National Laboratory has been referred to as has also the work under way at Argonne National Laboratory near Chicago. Both of these laboratories are engaged in the development of a high temperature type of reactor, and these projects naturally would result, if successful, in the actual production of power.

New Atomic Power Reactor to be built at Schenectady

Now, however, comes the encouraging news that the U. S. Atomic Energy Commission is acquiring 4500 acres of land in Saratoga County, New York, as the location of an experimental atomic *power plant* for studies in the generation of electric power from nuclear energy.

The plant will be part of the facilities of the Knolls Atomic Power Laboratory, operated for the Commission by the General Electric Co. at Schenectady.

The new Knolls reactor is one of two now being designed especially for the study of high temperature operation and the production of power. A different type of reactor but for a similar purupose is planned at the Argonne National Laboratory near Chicago. The design of both these reactors is directed to the problem of power generation by nuclear fission but by different methods, and both are expected to yield important data leading ultimately to the design of reactors which will produce power on a practical scale. They will also be valuable in solving some of the problems involved in "breeding" [1] nuclear fuel.

The Knolls Atomic Power Laboratory was established in November 1946 to carry on research in all phases of atomic power development. It is located on a site of some 180 acres obtained from the General Electric Co. and adjoining the company's own fundamental general research facilities. This site is not large enough to accommodate the new reactor and generating system.

The area for the new installation, upon which preliminary construction work will begin this fall, lies near West Milton, 10 miles west of Saratoga Springs and 15 miles northeast of Amsterdam. It is about 18 miles north of the Knolls Atomic Power Laboratory facilities.

Choice of the location was guided by the need to have the project near enough to Schenectady to permit ready and frequent use of the extensive technical and scientific resources of the plant and laboratories of the General Electric Co. Other important considerations in selection of the site were availability of water and power and suitability of underlying formations for the installation of heavy concrete structures.

The size of the acreage to be acquired was determined by safety and security requirements and by the need to provide freedom of laboratory action in carrying out experimental work, including the handling of radioactive materials. Additional advantages of the site are that it will require the displacement of fewer people and involve land of less agricultural productivity than other locations considered.

Operation of the reactor will involve the production and handling of radioactive materials, carried out in a closed cycle process that does not permit the escape of radioactive liquids or dust. In designing the Knolls reactor, G-E scientists and engineers have available the results of more than five years of experience of reactor operation in the United States. Experience in handling radioactive materials at many installations of AEC and nongovernmental institutions will be utilized on this project.

In authorizing the acquisition of the site, the Commission considered the dangers which might be created by a serious accident to the reactor. It is not possible to have a bomblike explosion. The rare type of accident which may create off-site hazards is in the nature of major damage to

the reactor resulting from sabotage, severe earthquake, or the remote possibility of simultaneous failure of all safeguards and control mechanisms.

In view of the remoteness of these contingencies and the emphasis on safety measures to be built into the plant, the Commission and the Company have concluded, on the basis of careful study by their respective staffs together with expert consultants, that the establishment of the plant on this site is fully justified. Throughout the development of detailed design, however, and during construction the work will be under continuing review, with testing of safety mechanisms prior to installation and final re-examination of the

(Continued on page 126)

[1] See, The Importance of Breeding in Nuclear Power Development. By Andrew W. Kramer; Oct., 1948 issue, page 86.

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

How Many Boiler Units for a Small Plant?

While the requirements of many of the smaller industrial plants are well within the capacity of a single boiler unit, and the single unit is probably the least expensive to install and operate, it may not always be the best bet in the long run. This point is stressed in the following analysis of a typical case, in which initial, operating, and maintenance costs, and the flexibility of the plant are compared

By WILLIAM W. GAYLORD, Consulting Engineer

THE TOTAL STEAM LOAD in many of the smaller industrial plants is well within the capacity of a single modern boiler unit. Where new boilers are being planned for such a plant, or old boilers are to be replaced, the question whether to use one or more units usually comes up.

The single unit will be the simplest, and probably the least expensive to install, but it may not be the least expensive to operate. Then, too, if it has to be shut down for repairs or cleaning, the whole plant must be shut down.

Two units, each of one-half the total capacity required, would make a more flexible plant and permit at least half the plant to be operated if one unit had to be shut down for any reason. If each unit were two-thirds the total capacity required, it is probable that one boiler could carry the whole plant load if the shutdown of one boiler occurred in any but the most extreme weather. Three units, each of about 40 per cent of the total capacity required, would make a still more flexible plant.

It is often desirable to provide space in the boiler room so that additional units can be installed to take care of a reasonable increase in the maximum steam demand should such occur due to plant growth. The analysis of a typical case will illustrate what can be expected with different sizes of units as outlined above.

Consider a plant having a considerable process steam load in addition to the seasonal heating load. The figured maximum steam demand for the equipment to be installed is 24,000 lb per hr. From data collected in a similar plant, it appears that the average day load for a cold winter day will be about 20,000 lb of steam per hr and the average summer day load about 11,000 lb per hr. It will be necessary to keep some process equipment hot 24 hours a day, so the minimum steam load is expected to be about 1000 lb per hr. Estimates based on data from a similar plant indicate that the total annual steam required will be about 73,000,000 lb.

It is expected that the maximum steam load may, in time, be increased by about 50 per cent due to plant extensions. Space will be provided in the boiler house for a unit, or units, to give this additional capacity, but equipment will be installed for present load only.

Initial Investment

Data have been received on water tube boilers of the type chosen, in a range of sizes with maximum outputs varying from 10,000 lb of steam per hr up to 30,000 lb per hr. Analysis of these data indicates that a single unit plant will have the lowest first cost. To provide some margin over the maximum estimated load, a unit having a heating surface of 4275 sq ft, and equipped to burn sufficient fuel to produce 28,800 lb of steam per hr, would be chosen. The estimated cost of this unit, complete with setting and fuel burning equipment, is about $42,500. The auxiliaries and building would add about $33,000, making a total cost of about $75,500.

If a two unit plant were to be chosen, each unit should have about 2400 sq ft of heating surface and be equipped to burn sufficient fuel to produce about 16,000 lb of steam per hr. The estimated cost of these two units, complete with settings and fuel burning equipment, is about $50,000. The auxiliaries and building would add about $34,500 making a total cost of about $84,500.

For a three unit plant, each unit should have about 1650 sq ft of heating surface and be equipped to burn sufficient fuel to produce about 10,500 lb of steam per hr. The estimated cost of these three units, complete with settings and fuel burning equipment, is about $50,000. The auxiliaries and building would add about $35,500, making a total cost of about $85,500.

Operating Costs

To compare operating costs an estimate of the fuel required based on using No. 6 fuel oil was made. In making this comparison, the number of hours the plant would operate at various percentages of full steam output was based on data taken from operating records of a similar plant. These showed that the expected load would be less than 30 per cent of capacity for more than 60 per cent of the time. These figures showed that the single unit plant would require about 620,000 gallons of oil per year; the two unit plant 606,000 gallons; and the three unit plant 605,000 gallons. At 5 cents per gallon for oil, this could make the annual fuel costs $31,000 for the three unit plant. If fixed or capital costs are taken at 10 per cent to cover taxes, interest and depreciation, these will be $7550 for the single unit plant; $8450 for the two unit plant; and $8550 for the three unit plant.

Comparing fuel and capital costs

only, the annual cost would be $38,550 for the single unit plant; $38,750 for the two unit plant; and $38,800 for the three unit plant. These are so close as to leave very little choice, but when maintenance costs, convenience of operation, and protection against shut-downs are considered, we get quite a different picture.

Maintenance

In the case of the single unit plant any cleaning, inspection or repairs would have to be done on an overtime basis as the unit must be operated all of the time the plant is in operation. The maintenance cost would also be higher as every effort would be made to keep the unit on the line until the regularly scheduled shut-down rather than to take care of minor adjustments and repairs as soon as discovered. Should any serious trouble develop that made it necessary to shut the boiler down, the whole plant must be shut down. While the availability factor of modern boilers is well over 90 per cent, this possibility must be considered.

With the two unit plant there will be six or seven months out of the year when one unit will carry the whole load so that any major repairs could easily be made during this period. It would also be possible to shut down one unit long enough to make minor repairs or adjustments during the off-peak hours the rest of the time. Should any serious trouble develop with one unit, it would not be necessary to shut the plant down, as it could probably operate at from 70 per cent to 80 per cent capacity on one unit even in the most extreme weather.

The three unit plant would be still more flexible in that all units running can be operating at their most efficient load and it would provide almost complete insurance against plant shut-downs.

Plant Growth

Finally, consideration should be given to the investment and operating costs should the load increase to a point where an additional boiler unit is required. It is almost always desirable to have all of the units in a plant of the same size so that only one set of spare parts need be carried. In this case, for simplicity, it is assumed that the maximum steam load will be increased in a single step from 24,000 lb per hr to 36,000 lb per hr so that the one unit plant now becomes a two unit plant with a capacity of 57,600 lb of steam per hr; the two unit plant becomes a three unit plant with a capacity of 48,000 lb per hr and the three unit plant becomes a four unit plant with a capacity of 42,000 lb per hr. Assuming the additional units to cost the same as the original units in each case, the total cost of the two unit plant is $119,000; that of the three unit plant $110,500; and that of the four unit plant $103,000. We now have the data on which to choose the unit or units for the installation.

The single unit, while lowest in first cost, is enough higher in fuel cost to nearly off-set this and its failure might easily cause an expensive plant shut-down. The first costs and fuel costs of the two and three unit plants are so nearly alike that there is very little choice, but the three unit plant offers more flexibility and insurance against shut-downs. It also has some advantages in flexibility if the load is to be increased and then becomes the lowest cost plant.

Thus in the case assumed, the three unit plant would be first choice, with the two unit plant a close second; but under other conditions it might work another way—thus showing the desirability of making an analysis of both investment and operating costs before deciding on the number of units to use.

PRACTICAL ENGINEER SECTION

TORSIONAL VIBRATION AND CRITICAL SPEEDS

By CHARLES BEHRENS

How many times have you been irritated as the refrigerator suddenly started up and the dishes on the pantry shelf began that constant hum, or the coffee-pot began to dance around on the stove? Or while riding on the street-car on the way to work—your newspaper begins to blur and jump so that you can only read when the car stops to pick up another passenger? Annoying vibrations like these are quite common, and while most of us have come to regard them as necessary evils, we are still quick to notice them.

The word "vibration" usually brings to the average person's mind the mental picture of some object undergoing a very rapid shaking or trembling movement; the way we shiver when we climb out of our warm bed on a cold morning! This is an obvious conception since that type of vibration is undoubtedly the most common and simplest to understand. Generally speaking, a vibration is a periodic motion which repeats itself, in all its particulars, after a certain interval of time.

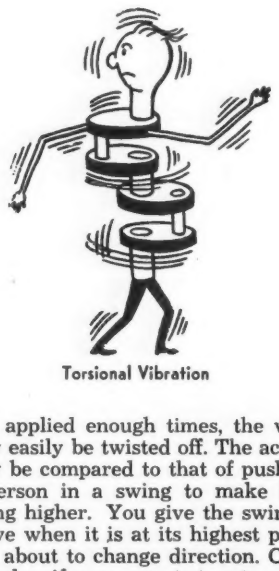
The development of high speed engines, steam turbines, generators, and other rotating machinery, emphasized vibrations to the point where vibration control is now an important problem to the design engineer. Most machines are now mounted on springs or rubber cushions so as to isolate the vibrations from the structure to which it is attached. The introduction of higher and higher rotative speeds, coupled with the increased power output of engines and turbines, introduced another form of vibration, known as a torsional vibration, which previously did not have to be considered. Today, torsional vibration is a common and serious problem in the design of engine crankshafts and turbine rotors and unless the designer properly allows for this condition, failure of the crankshaft or rotor may be the result.

A conception of torsional vibration is usually rather difficult to form because, unlike the more common types of vibration, it involves an entirely different and unique type of vibratory motion—a motion which consists of a "vibratory twist" superimposed upon the actual rotation of a shaft. This "vibratory twist," like other vibrations, is constantly changing from a positive maximum to a negative maximum. The maximum value of the amount of the twist is called the *amplitude* of the vibration. The interval of time, usually measured in seconds, required for a vibration to repeat itself, is called the *period* of the vibration; the reciprocal of the period is known as the *frequency*.

Your Newspaper Begins to Blur

In order to obtain a mental picture of the action of a torsional vibration, let us imagine that we have a piece of wire and have one end of it fastened in a vise. Suppose now we were to take a pliers and twist the free end; incidentally, how much we twist the wire will be directly proportional to the force we apply and the stiffness of our wire. If now, we suddenly released our grip, the wire would, quite naturally, untwist. However, after untwisting, the wire will "wind-up" again in the

opposite direction. The wire would continue to twist and untwist, each time a little less than the time before, until, after the lapse of a period of time, these *torsional vibrations* would eventually "die out" because of the dampening properties of the wire. However, if we were to again apply our torque, or twisting force, at just the proper instant, the twist would become greater than before. Also, if a series of similar impulses were applied, the amount that our wire is twisted, or the *amplitude* of the vibration, will be definitely increased. It is simple to understand that if our torque is great enough,



Torsional Vibration

and applied enough times, the wire may easily be twisted off. The action may be compared to that of pushing a person in a swing to make him swing higher. You give the swing a shove when it is at its highest point and about to change direction. Conversely, if you want to stop the swing, you push against it as it travels toward its highest position, or oppose the uniform motion of the swing. This may also be true in the case of our vibrating wire. If an opposing torque, that is, one which was not applied at the proper instant, were exerted on the wire, the result would be to decrease the amount of twist, or shorten the period of time required for the vibrations to cease.

Obviously, engine crankshafts are not held rigidly fixed at one end, but revolve between bearings. However, the generator rotor or fly-wheel, which if usually attached to one end, provides essentially the same conditions. If just an ordinary force, supplied by the piston or turbine blade, is applied, the shaft would merely twist as before, instead of begin to rotate. Also, the amount that the shaft is twisted would be seen to decrease from a maximum amount at the crank to zero inside the hub of the fly-wheel. That point is called a *node* because there is no twist at that location. If the system is rotating and a force is applied, this twisting action will also occur as when the fly-wheel was at rest.

Let us see what happens to the crankshaft of a one cylinder engine. At the first explosion in the cylinder the shaft will twist as before, and begin to vibrate torsionally. The next firing impulse would probably oppose the oscillation set up by the original explosion and tend to reduce the amplitude of the vibration. It should not be difficult to understand that at very definite speeds of our engine, the firing impulses may be synchronized with the natural vibration of the shaft set up by the original explosion. At such speeds, known as "critical speeds," the forces delivered to the crankshaft would add to the existing amount of twist and increase it markedly. Under such a condition, where the rate of impulses delivered by the engine is equal to the number of free vibrations of the crankshaft per unit time, "resonance" is said to exist. When resonance occurs, the amplitude of torsional vibration theoretically rises to infinity. Actually, it never reaches that point, but it does increase tremendously. This condition imposes additional stresses on the crankshaft which vary in intensity along the shaft and attain their greatest value at the nodal point. These stresses are repetitive stresses, and induce fatigue which often results in failure of the crankshaft.

These critical speeds are obviously of extreme importance to the designer. To avoid trouble from torsional vibrations as far as possible it is very desirable to be able to determine the critical speeds of a crankshaft or turbine rotor in advance so that the machine may be designed in such a way that it will never be permitted to operate at those speeds. For most practical purposes, the first critical speed is usually only of importance as the second is only occasionally reached. To avoid danger of operation at the critical speed, the designer may use some of the following procedures:

1. If the engine operates at a constant speed, as a synchronous-generator drive, changes in the stiffness of the shaft or variations in the shaft itself can be made so as to remove the operating speed sufficiently far from any critical speed.

2. This procedure will normally take care of the problem if the engine has to operate over a narrow speed range. If it does not, the severity of the critical speed may be reduced by changing the firing order.

3. If a wide range of speed is required, as in a Diesel locomotive, it may be very difficult, if not impossible, to avoid the danger of torsional vibration by means of 1 and 2. An artificial damper should then be installed.

Paper Mill Uses 1400 psi Back-pressure Steam Engines

WE ARE QUITE ACCUSTOMED in this country to steam pressures of from 1200 to 1400 psi in fact, even as high as 2300 psi as at Twin Branch Station, but we do not ordinarily associate such steam pressures with steam *engines*. For this reason, the engine shown in Fig. 1

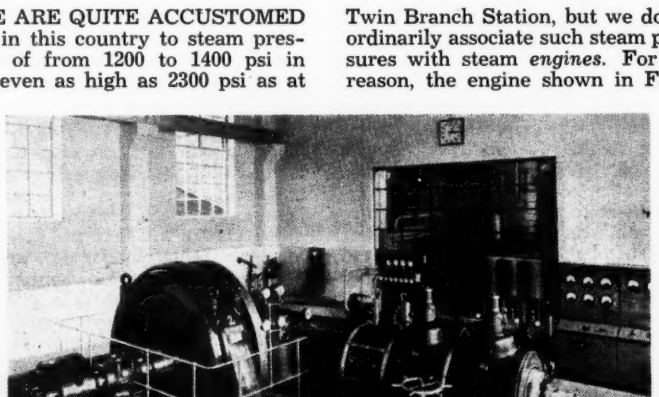
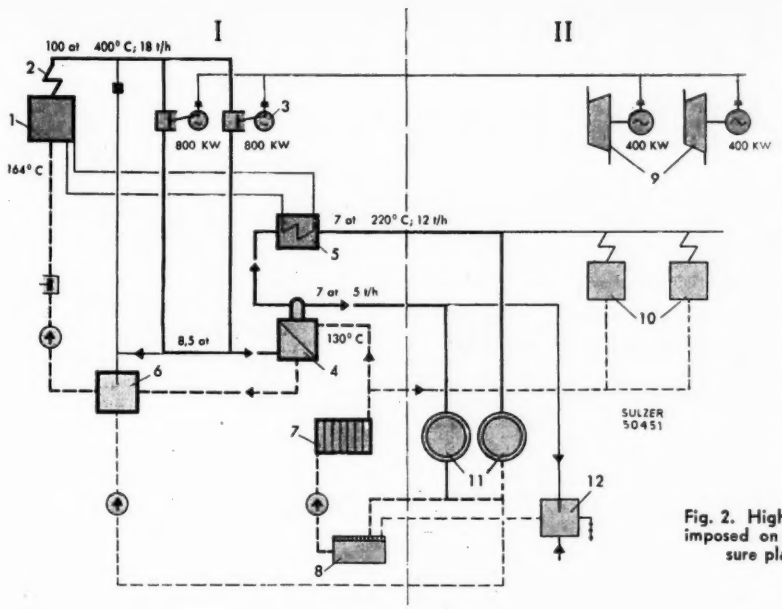


Fig. 1. Sulzer high-pressure back-pressure steam engine rated at 1200-hp at a live steam pressure at 1400 psi in paper mill



I Superimposed high-pressure plant
II Existing low-pressure plant

1 Monotube high-pressure steam generator
2 Superheater
3 Back-pressure steam engines
4 Steam transformer
5 Intermediate superheater
6 Condensate collector
7 Feed-water preheater
8 Water tank closed with steam cushion
9 Private water-power plant
10 Low-pressure boilers
11 Steam consumption points
12 Water treating plant

Fig. 2. High-pressure plant superimposed on an existing low pressure plant in paper mill

is of interest since this 1200-hp, high back pressure engine operates at live steam pressure of 1400 lb. Described in the No. 1 1948 Sulzer *Technical Review*, this engine was installed as a "topping" unit in the power plant of an existing paper mill. It is one of two such engines constituting the high pressure unit. The flow diagram of this plant is shown in Fig. 2.

Additional Electrical Energy

The steam supplied by the boiler is expanded in the two high back-pressure reciprocating engines (3) down to 120 psi and then goes to a steam transformer (4) in which steam at 100 psi is generated and supplied to the existing low-pressure system. Part of the steam from the transformer is brought up to 430 F in an intermediate superheater (5) for manufacturing requirements. The additional electrical energy required is supplied by a water power plant (9) operating in parallel, or else by the electricity works. The existing low pressure boilers (10) serve as a standby. This plant has been in service for ten years and has given complete satisfaction. The 1400 lb engines were built by Sulzer Bros. Ltd., at Winterthur, Switzerland.

As in this case, the solution of a power problem is not necessarily the design of a new steam installation, that is a new power plant. Great savings are possible by the modernizations and extension of the existing plant. Such modernization is justified not only where a plant has ceased to be capable of meeting rising power and heat requirements but also where the heat utilization and thus the economy of the plant is no longer satisfactory. The capital outlay for such alterations can usually be covered in a fairly short time by the savings that result.

"No, I don't think it's a bit funny—and put that nameplate back on my desk!"

PRACTICAL HINTS AND KINKS

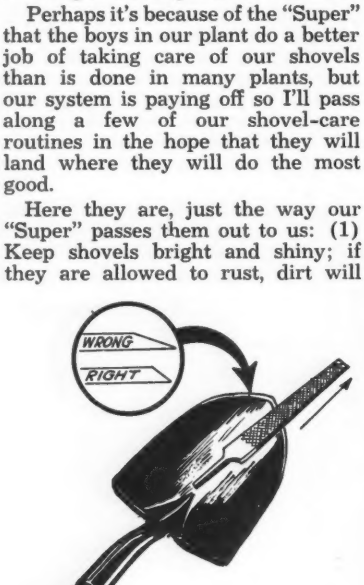
KEEP SHOVELS SHARP AND BRIGHT

By JOHN G. REYNOLDS

OUR "SUPER" has a pet peeve that will set him off on a tangent quicker than a vote at UN headquarters will cause the Russian delegates to take a walk. However, in the "Super's" case it doesn't take some phase of international relations to stir up his gander; the sight of a dirty or mud covered shovel on one of our trucks or in the storeroom is enough to start a general inspection of all tools.

Perhaps it's because of the "Super" that the boys in our plant do a better job of taking care of our shovels than is done in many plants, but our system is paying off so I'll pass along a few of our shovel-care routines in the hope that they will land where they will do the most good.

Here they are, just the way our "Super" passes them out to us: (1) Keep shovels bright and shiny; if they are allowed to rust, dirt will



How To Sharpen a Shovel

stick to them and double the effort required in using them; (2) a shovel which has been allowed to become rusty can be brightened with a fine sand paper or emery paper followed by treatment with oil or an anti-rust compound; (3) shovels should always be thoroughly cleaned and oiled after use; (4) shovels should be sharpened so that the back of the shovel is perfectly flat from the cutting edge back and with a uniform bevel along the cutting edge on the face of the shovel; the bevel should be rather steep so as to give the cutting edge some stability otherwise it will tend to burr and interfere with proper digging (see sketch)

Our final shovel routine is an occasional treatment of the handle with a solution made up of 2/3 linseed oil and 1/3 turpentine, which acts as a preservative. For safety's sake all rough and splintery edges should be carefully sanded off before applying the treatment.

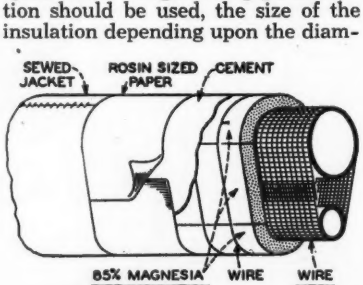
TIPS ON INSULATING STEAM-TRACED AND STEAM-WRAPPED LINES

By THE MAGNESIA INSULATION MFRS. ASSOC.

IN THE CASE of steam-traced piping, a steam line, generally an inch or less in diameter, is run parallel to a process line carrying material which must be kept hot. With steam-wrapped piping, the steam line is wrapped spirally around the process line. In either case the insulation construction should surround both pipes so as to permit the heat to be transferred from the steam to the process line.

With steam-traced lines, half-sections of semi-cylindrical molded pipe insulation, each half of a size appropriate for its respective line, should be fitted around the process line and the steam pipe. At the two sides, blocks of the same thickness as the pipe insulation and cut to fit, should be carefully fitted between the semi-cylindrical sections. The half-sections and the side blocks should be tightly butted together and firmly fastened in place with iron wire. All the joints should be pointed up with asbestos cement, and the entire outer surface covered with a layer of the cement reinforced with hexagonal wire mesh and troweled to a smooth, hard finish. In some cases, before the insulation is applied, the two lines may be wrapped with wire mesh.

Steam-wrapped piping should be covered with a layer of galvanized expanded metal lath, laced in place with iron wire. The lath serves as a firm foundation for the insulation which should then be applied. Semi-cylindrical or segmental pipe insulation should be used, the size of the insulation depending upon the diameter of the process pipe plus the steam pipe. Insulation application is the same as for any pipe insulation job. The insulation sections are applied, joints butted tightly together, and fixed in place with iron wire.



Magnesia insulated steam traced pipe for an indoor installation

Depending upon the operating conditions involved, various finishes such as cement, sewed canvas, asphalt saturated asbestos roofing felt, metal jackets, etc., may be used to cover the insulation.

ECCENTRICITY IN COMMUTATORS

By W. E. WARNER

ECCENTRICITY is likely to develop in all commutators, especially in machines which have seen much wear. In high speed machines this may cause much trouble, especially as the distortion which causes eccentricity is magnified at high speeds. The causes are the out of round rotation which is likely to occur when the machine is running. First there is the natural whip of the shaft which causes a certain amount of distortion at high speeds, but this is small as the commutator is closely supported by a bearing.

The usual practical cause is warm bearings combined with an unequal magnetic pull around the circumference of the armature. Bearings are bound to wear in time, but whenever possible, ball or roller bearings should be used as with these the wear is negligible. With plain bearings proper lubrication, using a sufficiently heavy lubricant, will help to prevent out-of-round rotation by helping to take up the clearance.

There is also the question of a non-uniform magnetic flux round the armature. The usual cause of this is unequal air gaps. If the air gap is smaller between some pole pieces and the armature, than others, the armature and shaft will be drawn hardest to one side giving the commutator and armature shaft an out-of-round rotation. Under these conditions the wear of the brushes will soon cause the commutator to assume an eccentric shape.

These unequal air gaps may also cause bearing wear and heating. Even a small amount of bearing wear is magnified when the armature shaft is working at full speed, therefore the bearing clearance must be kept as small as is consistent with safe operation.

SELECT PAINT FOR SUITABILITY AND LASTING WEAR

By JOHN G. REYNOLDS

LIKE MANY OTHER companies we have discovered through the well-known trial and error method that the selection of paints used for protection of outdoor structures and equipment must take into consideration the materials used in the con-

struction of the equipment, the present condition of the equipment and the conditions of exposure to which the equipment may be subjected. With those considerations in mind it is plain to see that paints used around the plant should combine the greatest possible rust-inhibitive and protective properties with a convenient and simple method of application and as it is not always possible to clean equipment thoroughly the paint should bond well with firm rust. Also the paint must adhere to galvanized surfaces as well as black iron; the resulting film should resist wind and weather, including rapid changes in temperature and provide protection from chemical fumes.

To locate a paint possessing all of those qualities was a task that had our purchasing agent talking to himself until he discovered a paint known as "Subalox." This paint is based on a colloidally dispersed and amorphous pigment of sub-oxide of lead which is so chemically active that it beneficially changes the film through weathering, increasing its rust inhibitive properties as well as its hardness. Because it acts very much as a filler and digs into the surface it is ideal as a primer on bare or rusty surfaces. On the other hand it also lies smoothly over the surface and has some of the leafing associated with aluminum, making it especially suitable for applications to galvanized surfaces, over old paint and as a single or finishing coat.

We have found Subalox unexcelled for painting lined stacks or unlined stacks. The regular mixture will withstand temperatures ranging up to 350 to 400 F metal temperature, and a special heat resisting variety is reinforced for particular conditions and will withstand possible 100 deg additional temperature. For stacks having a metal temperature (metal temperature is estimated to be the temperature of the gases at the intake plus maximum weather temperature divided by two) of 500 deg a variety of the paint known as Aluminox CG[1] is recommended. For boilers not subject to water or weather, Aluminox C[1] give exceedingly good results with a very bright appearance.

MOLYBDENUM is used chiefly as an alloy in the production of high-speed tool steels, in alloy steels for Diesel engines, automobiles, trucks, aircraft, and also as a catalyst in the chemical production of colors for dyes and in the electronics industry. Prior to World War I, says a Twentieth Century Fund report, only 13 per cent of the world's small output was produced in the United States. In 1937, however, we were responsible for 92 per cent of world production and 37 per cent of world consumption.

LETTERS AND COMMENTS

FLUORESCENT LAMP MYSTERY

By CLARENCE W. HOPE

AN INTERESTING electrical problem arose in our plant recently. The electrician was sent out to replace an incandescent lamp fixture with a fluorescent lamp unit, the fixture in question being No. 4 on the accompanying diagram. He removed fuse No. 2 which controlled lamps No. 3 and No. 4 and installed the fluorescent fixture. About the time he finished the klaxon relay began to operate and every time its contacts closed lamp No. 3 would light up brightly, much to his surprise.

We were curious about what caused this condition and assumed that there must be contact between the telephone wires and the light wires. We started to look for the fault when lamp No. 3 started to glow at one-half voltage and we received word from the next floor that the wall fan would run at only one-third speed and hall light No. 2 burned dimly. The klaxon started again and light No. 3 came on brightly while light No. 2 went out. We realized that the trouble was in the method of wiring—not a fault—and so traced out the wires in the conduits to enable us to draw the diagram as shown. With this we were able to understand what was causing these will-o-the-wisp light flashes and dimly burning bulbs, for the solution lay in the fact that the fuses in the panel board supplied both 110 v and 220 v apparatus.

With fuse No. 2 removed, current flowed through fuse No. 1, switches and lamps No. 1 and No. 3 to the neutral, making a series circuit on the 110 volts. Current also flowed through the 220 volt transformer and the wall fan to lamp No. 3 and the neutral. No. 3 lamp would then burn at about one-third voltage. When lamp No. 2 was switched on,

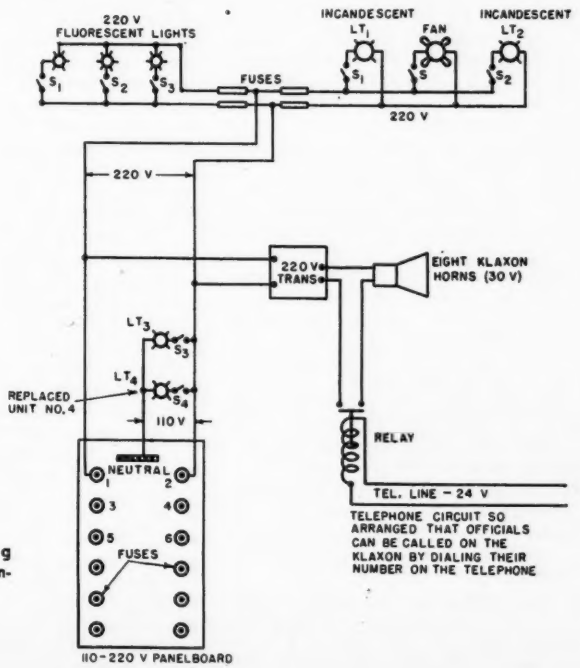


Diagram showing how lamps were connected

PRACTICAL ENGINEER SECTION

it glowed at about one-half voltage and caused No. 3 to do the same. When the klaxon relay was started it put a load on the transformer allowing more current to flow through it so that lamp No. 3 burned at full voltage while lamps No. 1 and No. 2 would go out.

Though the solution was simple it certainly had us guessing for a while. It also shows why units should not be wired this way.

POWER FROM PROCESS STEAM AT ROEBLING'S

IN THE AUGUST issue of POWER GENERATION appears an article by Wm. E. Zelley titled "How Power from Process Steam Will Pay at Roebling's."

The information on cost comparisons of purchased power and generated power is fine, except that it is considerably short of telling the whole story.

I believe that the following points should be included in order to make the subject article complete:

1. (a) Cost of installing new low-pressure equipment to supply process steam to replace old inefficient equipment.
   (b) Cost of purchasing all electric power.
   (c) Cost of operation of new low-pressure equipment including fuel and labor costs.
   (d) Amortization and interest costs for new low-pressure installation.
2. (a) Cost of installing new, relatively high-pressure equipment, including steam-generating equipment and electric-generating equipment, including the condenser equipment.
   (b) Cost of generating process steam, generating a part of the electric power, and purchasing the remainder of the electric power, including fuel costs and labor costs.
   (c) Amortization and interst costs for new, relatively high-pressure steam generating and electric generating equipment, including the condenser equipment.

By including the points as outlined in the above paragraphs, the comparison will bring out the following information:

A. The difference in cost of equipment and piping between the low-pressure installation and the relatively high-pressure installation.

B. The difference in amortization and interest costs between the two systems.

I believe that an analysis of the material presented in Mr. Zelley's article on the basis outlined in this letter will give a clearer conception of the return on investment than indicated by the figures in the article.

ROBERT H. SHANNON
Havertown, Penna.

Editor's Note:—The above procedure is, in general, followed by all competent power engineers in analyzing a proposed plant. However, Mr. Zelley refers at the beginning of his paper to a survey of load conditions and other factors. In view of the details in the paper, it does not seem reasonable that the survey should have failed to cover the points brought out by Mr. Shannon, even though they were not brought out in the original paper. We have asked Mr. Zelley about them.

HOW A LEAKING DISCHARGE VALVE CAN STALL AN AIR COMPRESSOR

By H. B. McDERMID

ON A LARGE power plant construction job, a sub-contractor on small steel details had a nearly new gas engine driven portable air compressor for use in his riveting work. The unit was designed with its compressor cylinder set in tandem above the engine cylinder, with, of course, a common piston rod for the two cylinders. It commonly operated to build up 110 psig in its air receiver, and was capable of producing all the volume needed for the riveting hammers on the job.

One day the unit stalled with only about 70 psig air pressure in the tanks. This was too little to do any riveting work, and no amount of coaxing and re-starting, and changing of the gas engine mixture would do any good; the outfit would pump up to a low pressure and stall every time. The steel foreman tried all the tricks he knew to no avail, and finally appealed to a mechanical foreman nearby for advice. Some air compressor experience, and a few moments study of the symptoms enabled him to solve the problem and diagnose the trouble.

A Leaking Discharge Valve

Due to the gas engine design, with no great excess power in its size, the usual indications of excess heat failed to show up for the leaking air compressor discharge valve which proved to be the trouble: The gas engine could provide only a small percentage of overload power, due to the fact that its cylinder had to work at atmospheric pressure. Therefore, it could get practically no increase in fuel, nor the air with which to burn it. The cylinder size was fixed—so once operating at capacity, there was no way to increase the load it could carry. There was nothing the unit could do but stall, when the load was increased by the leaking valve, without operating long enough to produce the usual excessive heat in the compressor discharge pipe.

The writer has known of electric motor driven compressors, with well engineered V-belt drives to motors of a considerable percentage of overload capacity, that would heat the compressor discharge pipe to a bright red for ten feet from the cylinder when the valve leaked. An accompanying threshing and distress would show up in the belts, when the really good operator was away for only a few minutes. The only course was an immediate shut down, and as rapid a repair as possible, with the later setting up of a proper schedule of maintenance for the discharge valves at regular, rigidly followed intervals.

In the case just described, the danger of an explosive mixture of gases under high pressure from the overheated lubricating oils is not to be ignored, especially since plenty of highly incandescent carbon and metals are present to set it off. One hears of such troubles, and the writer is not one who needs first hand proof of the danger before he will take reasonable precautions.

How Leaky Valve Stalls Compressor

The following is an analysis of what happens in the above examples with the leaky compressor discharge valves. In the normal air compressor piston stroke, the intake valve opens as the piston recedes from the head of the cylinder; at the end of the intake stroke there is a pressure within the cylinder, somewhat less than atmospheric. As the piston starts to compress that charge, the pressure within the cylinder builds up gradually, until the discharge pressure is reached. The last small percentage of the stroke is completed under discharge to the system. Now, suppose the discharge valve leaks badly, the high pressure air fills the cylinder as the piston recedes from the head, and the cylinder is full of air at more or less high pressure. This depends on the severity of the valve leak, at the start of the compression stroke, instead of the normal pressure of one atmosphere or less. The unit is forced to work at nearly maximum load for the full stroke, instead of a very light load at the beginning, building up to the maximum load at the last end of the stroke, as in normal operation. As a result, in the case of the gas engine driven unit, the machine simply stalls and can go no farther till the offending valve is put in proper order. In the motor driven case, the outfit keeps going until destructive and dangerously high temperatures are developed, providing there is excess power to keep the unit going. In either case the remedy is preventive maintenance, if one is to avoid costly, sometimes puzzling, and perhaps, dangerous, shutdowns.

Questions and Answers

PRACTICAL ENGINEER SECTION

Question No. 432

HOW CALCULATE CENTRIFUGAL REFRIGERATING COMPRESSOR TONNAGE?

I AM OPERATING a centrifugal refrigerating compressor rated at 277 tons and using Carrene (CH_2C_{12}) as the refrigerant. Will Q & A readers give me the formulas for calculating the tonnage of this machine and show how to work them out?

This system operates under vacuum, as readers know, and here are some operating data on it:

Compressor driving motor:
350 hp, 440 v, 1770 rpm stepped up to 3675 rpm at compressor by gearing; motor draws 540 amp.

Cooling water pump:
670 gpm, 130 ft head, 1750 rpm size - 4 in.

Spray pond pump:
1200 gpm, 95 ft head, 1730 rpm; size - 6 in.

Refrigerant temperature:
35 F.

Operating readings:
Cooler side
25 in. Hg Vacuum
Cooling Water
In—48 F; Out—40 F.
Condenser side
5 in. Hg Vacuum
Spray Pond water
In—84 F; Out—89 F.

New York J.L.T.

Question No. 433

DO COAL-FREEZING PREVENTIVES CORRODE COAL-HANDLING AND BURNING EQUIPMENT?

I ENJOYED Julian E. Tobey's comments on coal quality in the August issue of POWER GENERATION also the discussion of handling frozen coal in the September issue. They lead to this further question: What effect on equipment may result from coal beneficiation by washing and by coal treatment to prevent freezing?

That is, what dangers or corrosion problems, if any, may be expected from the use of various percentages of calcium chloride or rock salt both in the coal-handling system of a power plant (bunkers, belts, conveyors, piping and the like) and in the combustion and cooler heat-exchange portions (metallic and refractory) of a large pulverized coal-fired, high-pressure steam boiler?

Any data based on past actual experience will be appreciated by many engineers besides myself.

Ohio F.M.R.

Answer No. 427

HOW HANDLE CHLORINE CYLINDERS?

BECAUSE so many power plants use chlorinating equipment for chlorinating condenser circulating water, P. H. asked in the September issue for information on handling the chlorine cylinders used in this process. He wanted to know how chlorine cylinders are unloaded and stored and what precautions the operators take in handling them.

The answers below give ways in which individual engineers handle chlorine in specific plants, together with some general instructions that may apply to many situations. Note that several answers state that information on this subject may be obtained from the Chlorine Institute. Further details on this institute and its data will be supplied on request to the editors.

Observe Safety Rules and Make it a Routine, Safe Operation, Says Spencer

CHLORINE HANDLING and storage may be made a routine and nonhazardous operation by observance of a few safety rules.

Chlorine is delivered either in tank cars or in steel cylinders containing one ton of gas. However, when shipped in cylinders, it is usually shipped on special railway cars holding fifteen cylinders. Methods of delivery should be determined by conditions existing at the user's plant, realizing that the multiple-cylinder cars require more labor for hauling.

Tank cars are usually placed on a spur track and the gas, or liquid, used directly from the car. Cylinder shipments are generally unloaded and the car returned with empty cylinders.

Unloading the cylinders is easily accomplished by the use of the lifting beam shown on Fig. 1. Cylinders

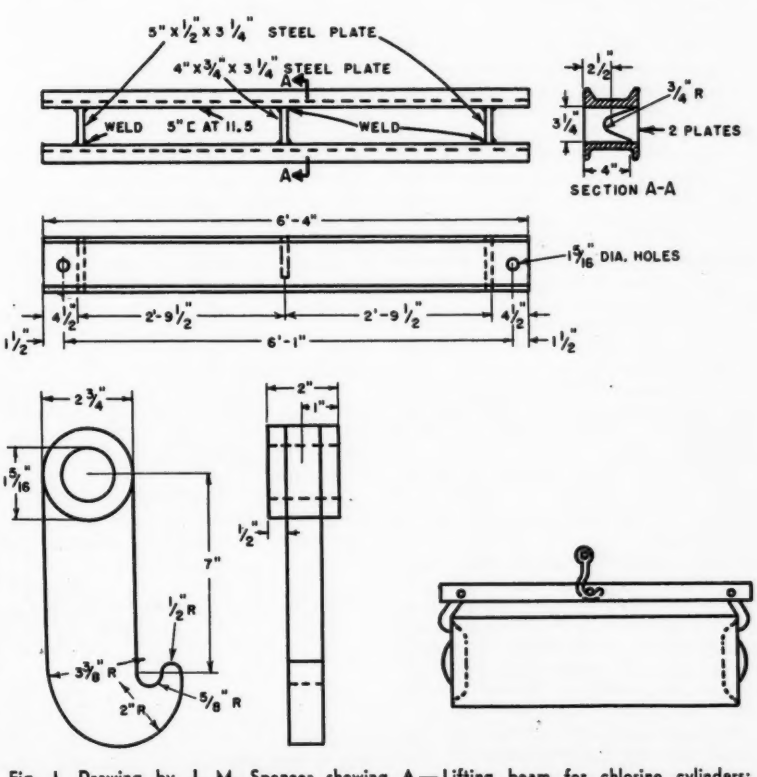


Fig. 1 Drawing by J. M. Spencer showing A—Lifting beam for chlorine cylinders; B—Steel hook for lifting beam; C—Method of using lifting beam in handling cylinder

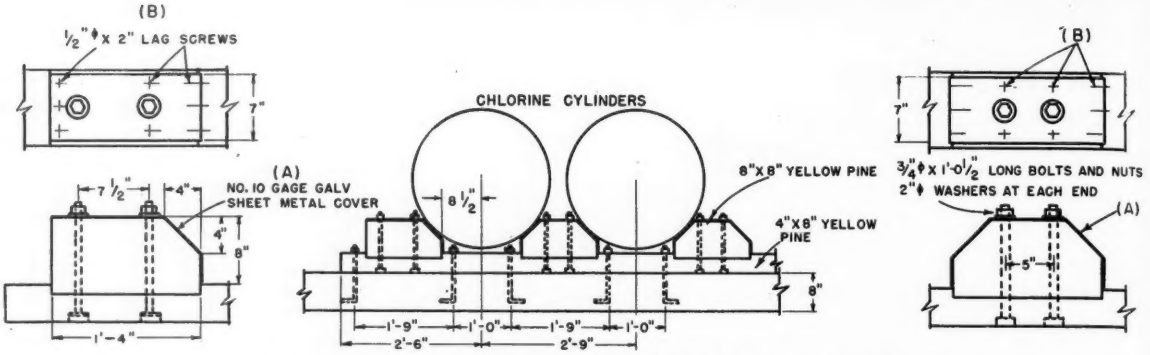


Fig. 2 Storage rack for chlorine cylinders, as described by J. M. Spencer

vary in dimensions and it would be well to check with the vendor before fabricating special equipment. Mobile cranes or stationary hoists may be used, again depending on the particular problems of the user.

If chlorine is to be used at but one location, the storage racks should be adjacent to point of use, but for scattered points of use a central storage has certain advantages.

For central storage, outside facilities offer the cheapest installation and one entirely satisfactory. Storage at the point of use may or may not be protected. This will depend partly on the type of chlorinating equipment used.

Some machines use gas directly from the top of the cylinders, and in this case heat of evaporation must be supplied through the cylinder wall. In very cold weather, trouble may be experienced on this score, although it can be minimized by using several cylinders at once.

Some equipment uses liquid from the bottom of the cylinders, passing it through evaporators. For this type of equipment outside storage should be satisfactory. One type of storage rack is illustrated in Fig. 2.

If inside storage is used, a ventilating blower should be installed to quickly clear the room in case of leaks. Direct rays of the sun on cylinders stored in the open will, of course, raise the pressure of the gas in the cylinders.

In general, chlorine suppliers do not recommend unprotected storage, but it is the writers opinion that it is entirely safe.

Gas masks need not be used for making connections; but should, of course, be available in case of an emergency.

Some users of chlorine find it advisable to weigh the bottles periodically to determine consumption. This is most easily done with a scale designed to fit between the lifting beam and the chain hoist or other lifting mechanism. Bottle weights may be checked by raising the cylinder one inch. Cylinders in service need not be disconnected for this operation.

Much additional information can be obtained from both the chlorine manufacturers and the manufacturers of chlorinating equipment.

Dundalk, Md. J. M. SPENCER

Comments from Rixman

LIQUID CHLORINE is shipped in strong steel cylinders weighing 100, 150 and 2000 lb net. The cylinders add about 60 per cent more weight. Care should be used in handling the cylinders; the smaller ones may stand upright, the ton cylinder on its side. They may be carted in hand trucks, the ton cylinder requiring a crane or overhead rail hoist to lift from the cars.

Store cylinders in a clean, dry place or shed; arrange them in racks so they will not fall or roll away. Keep them at 50 to 100 F; the pressure in the cylinder depends on the temperature. At 0 F this will be 16 psi; at 100 F it will be 150 psi. Don't overstock. Keep cylinders near place of use. Remove the caps only when a new cylinder is needed. Replace old caps, tear off lower half of tag and mark M.T. and set with other empty cylinders for prompt return.

Fusible plugs are on each valve of the small cylinders, on each end of the ton job. These release at 165 F.

Small amounts of gas are not harmful. A mask in good condition comes in handy in an emergency. A means of quick exit and a water hose should be nearby. Stop all leaks, as gas is corrosive.

To change cylinders, simply close the main valve, then the auxiliary valve and uncouple it. Use a new gasket of special lead for the new connection.

On large installations, chlorine control apparatus is used and tests are made for residual chlorine to control slime and algae. Small jobs use chlorine in powder form with good results. The amount of chlorine required depends on the water condition and circulation and amount used. A competent chemist or laboratory or chlorine control equipment company could estimate the probable cost and best method of control.

Cincinnati, Ohio WM. RIXMAN

Martinez Gives His Experience

IN OUR PLANT, we use chlorine equipment not only for the circulating water, but also for the aqueduct and the sewage plants; so we have some experience we can offer P. H.

Chlorine cylinders come in three sizes: 100 lb, 150 lb, and 2000 lb. In handling them, the usual practice is to use an overhead crane or trolley to carry the cylinders in the horizontal position. The cylinders should be handled with care; they should not be dropped and should not be allowed to strike each other violently. The protecting caps should be ON all the time the cylinder is being moved. If very few cylinders are used, or if the available space is too small, they may be stored and handled in the vertical position.

Chlorine containers should be stored in a dry, protected place, where they are not subject to too high or too low temperatures, and where there are no fire hazards.

The pressure inside the cylinder will vary depending on the ambient temperature. In very hot weather, it may be as high as 150 psi while in cold weather may be as low as 40 psi. The pressure in the container keeps the chlorine in liquid form and when the valve is open some of the chlorine passes into gaseous form.

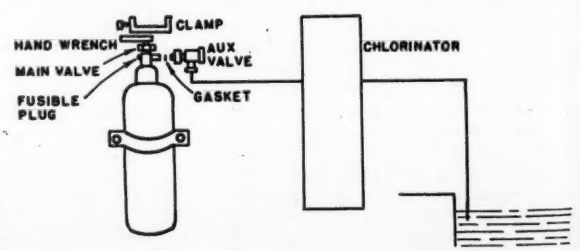


Fig. 3 Wm. Rixman shows how chlorine cylinder is connected

The rate of withdrawal of chlorine is limited, since the evaporation of the liquid into gas requires heat, which must be obtained from the surrounding air. If the gas is drawn off too rapidly, frost will appear on the outside of the container and the freezing will retard the passage of heat. If a high discharge rate is needed, several cylinders should be connected in parallel. *Under no conditions* should the cylinder be heated by any means over 130 F to accelerate the withdrawal of gas.

It is not necessary to wear gas masks while replacing cylinders and making connections, but the mask should be in a place easily reached. Leaking chlorine is easily detected by its sharp irritating odor, and can be easily located by a bottle containing ammonia, since the ammonia reacting with the chlorine produces white fumes. When a leak is noticed, locate it as soon as possible and stop it, because once started it will increase rapidly in size.

Bauta

Havana, Cuba — SERGIO MARTINEZ

Livingston Describes His Method

IF P.H. will contact the Chlorine Institute, the nearest chlorine dealer to his plant, and a manufacturer of chlorinating equipment, they will gladly give him information that will assist him in solving the problems relating to his particular plant. Also, they will give him a list of actual installations that he may visit.

Below are some details concerning one of the chlorinating plants that I assisted in designing.

The cylinders, one-ton capacity, and seven in number, are stored in a room adjacent to the room containing the chlorinating equipment. This room has a concrete floor, pitched and drained, about one foot higher than the surrounding ground level. It is in an isolated position, exposed to the winds from all directions. There are a number of louver ventilators at floor level, and a few higher up, so that the room is drafty, and has no pockets where chlorine gas may settle or accumulate. There are no windows, hence sun does not shine on the cylinders. The cylinders rest on heavy wooden skids, or cradles.

The cylinders are delivered to the plant usually three at a time in a motor truck. The truck is backed into a covered unloading space at the end of the room. The cylinders are picked up from the truck by an electric monorail hoist, by means of a strongback, moved into place and lowered onto the skids. The scales, shown on the sketch, are used to check the weights of the cylinders to determine when they are empty, or if the discharge connections may be plugged up.

In moving the cylinders, care is taken to avoid striking or jarring the cylinders, or allowing them to strike anything else. Nothing is allowed to be stored in the cylinder storage room; it is kept clean and dry at all times; and plant orders prohibit anyone but the chlorine plant operators from entering the building. Nothing is allowed to be stored within a certain minimum distance outside the building, and the outside premises are kept clean at all times.

Each cylinder is connected to a header, which leads to the evaporators in the chlorinating plant. The flexible connections, and the tank and header valves are all of the type approved by the Chlorine Institute. The chlorine cylinders are cut into service successively.

The plant was designed, based on experience with two earlier ones, by co-operation of the designing engineers, the operating engineers, and recommendations of the chlorine dealer and the engineers of the manufacturer of the chlorinating equipment. It was also designed to meet the local underwriter's requirements and city ordinances. The latter required chlorine traps in all drain lines from the plant to prevent the discharge of chlorine-charged water to the sewer.

To answer the specific questions asked by P.H.—

1. Handle the cylinders as little as possible. If at all possible, lift them from the delivery truck and lower them into place immediately, to eliminate a second handling. Do not handle them roughly. Keep well away from fire-rooms, hot steam pipes, etc. Keep well away from inflammable materials, or fires.

2. Trucks or push cars should have cradles in which the cylinders rest. The cylinders should be lifted by monorail hoists, with strongbacks to grasp the cylinders. Never use rope or chain slings. Davits or revolving cranes, unless very carefully used, may start the cylinders swinging, and cause them to strike something. Do not roll the cylinders along the platform.

Small cylinders of 150-lb capacity may be handled on warehouse trucks. However, such trucks should be balanced, and have a clamp to hold the cylinder in place. Small cylinders may be stored on end, but should be clamped to the wall to prevent falling over, and should be stored where they will not be struck by passing trucks.

3. Part of this question I am unable to answer from experience, because particular care was taken to eliminate the conditions mentioned.

Chlorine cylinders should be stored in a well-ventilated room, or else under cover outdoors where they will be protected from direct sunshine, rain, or snow. They should be stored well above ground, not allowed to become wet or dirty. Extremely hot sunshine will increase the pressure in cylinders, while extreme cold will reduce it. For proper control of the chlorinating equipment, it is best to maintain a fairly uniform temperature in the cylinders, which will insure a uniform discharge pressure. I would say that the extremes of temperature plus rain or snow mentioned in the question would make it both very disagreeable and dangerous to handle chlorine cylinders.

4. The operators should wear gas masks when handling the cylinders and making connections. No man should be allowed to do either until he has been properly instructed. In addition, he should be the type of man who can be trusted to discharge his duties safely and carefully. The gas masks should be stored outside the cylinder storage room, but close to it where they are readily accessible when needed.

Highly important: When handling chlorine cylinders, take particular care not to injure the valves, connections, or fusible plugs.

Los Angeles, Calif. — HOWARD T. LIVINGSTON

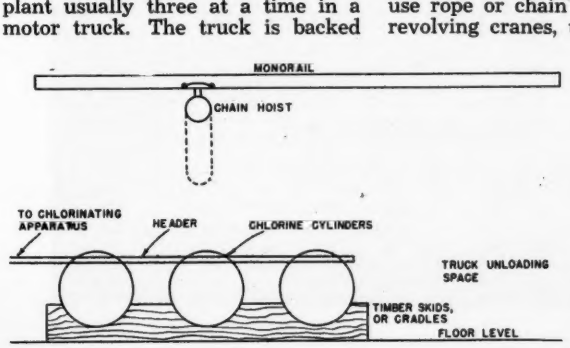


Fig. 4 Diagrammatic elevation of chlorine storage room as designed by Livingston

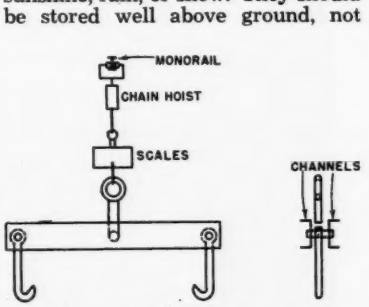


Fig. 5 Livingston handles cylinder by lifting beam or "strongback" similar to Fig. 1

STAINLESS STEEL DATA SHEET

Austenitic Stainless Steel

	COMPOSITION IN PERCENT								
A.I.S.I. Type	C Max.	Mn Max.	Si Max.	Cr	Ni	Mo.	Ti Min.	Cb Min.	Common Name
302	.20	2.00	1.00	17-19	8-10				18-8
304	.08	2.00	1.00	18-20	8-10				18-8 S
309	.20	2.00	1.00	22-24	12-15				25-12
310	.25	2.00	1.50	24-26	19-22				25-20
316	.10	2.00	1.00	16-18	10-14	1.75-2.50			18-8 Mo
*	.10	2.00	1.00	16-18	10-14	2-3		8xC	18-8 Mo Cb
321	.10	2.00	1.00	17-19	8-11		4xC		18-8 Ti
347	.10	2.00	1.00	17-19	9-12			8xC	18-8 Cb

*No type number yet assigned

PROPERTIES COMPARED

(Data assembled from various literature sources)

COMPARED METALS	Approx. melt. pt. in °F.	Weight in lbs. per cu. in.	Weight in lbs. per cu. ft.	Weight ratio*	Specific heat ratio*	Thermal conduct. ratio*	Expansion ratio*	Modulus in millions
302	2600	.290	500	1.0	1.0	1.0	1.0	28
304	2600	.290	500	1.0	1.0	1.0	1.0	28
309	2600	.290	500	1.0	1.0	0.9	0.86	29
310	2600	.290	500	1.0	1.0	0.9	0.86	29
316	2525	.290	500	1.0	1.0	1.0	0.93	28
321	2600	.290	500	1.0	1.0	1.0	1.0	28
347	2600	.290	500	1.0	1.0	1.0	1.0	28
Carbon Steel	2700	.284	490	0.98	0.9	3.0	0.69	29
Nickel**	2645	.322	560	1.13	0.94	2.2	0.83	30
Copper**	1980	.323	560	1.13	0.67	14.7	1.0	16
Aluminum**	1215	.098	170	0.34	1.9	8.3	1.4	10
Magnesium**	1204	.063	109	0.22	2.1	5.9	1.6	6.3
Beryllium**	2345	.066	114	0.23	3.6	6.1	0.7	43

*Approximate ratios–Type 302–1 **Commercially pure metal.

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Factors Influencing the Design of Gear Sets

This article tells what the user or prospective purchaser of gear sets should know about their design. A knowledge of the basic principles is helpful because the selection of a proper gear set is not just a routine matter; often, two similar applications will require different sized gears. Mr. Benford explains the fundamentals of gear sets by designing a hypothetical line of general purpose gear sets, showing the evolution of the various computations

By L. R. BENFORD Gear Engineering Division, General Electric Co., Lynn, Mass

HOW MUCH OF the basic principles involved in designing gear sets should the user or prospective purchaser of them know? Enough, certainly, so that he can get the most efficient use from them as a result of appreciating their capacities and limitations as established by their physical dimensions and factors.

A knowledge of these capabilities and limitations, too, will be extremely helpful in explaining a point that designers know is extremely important. This is that two similar applications may require different-sized gears.

These points are perhaps best illustrated by starting from the beginning and designing a hypothetical line of general purpose gear sets, showing the evolution of the various computations. The first item for consideration is capacity.

The rating or capacity of a gear set, consisting of the smaller gear (pinion), the larger gear (L.S. gear, gear, wheel), shafts, bearings, casings, and accessories, is based on the transmitted torque. The input and output torques determine the sizes of shafts, pitch diameters, and tooth face widths, and the tangential force resulting from the torque determines the bearing sizes.

It is not fully practical to cover all the possible variables in a mathematical way, but it can be demonstrated that the input torque and the speed ratio are sufficient to determine the distance between shaft centers, width of tooth faces, sizes of bearings, and shaft diameters. The sizes of other important parts will be selected on practical bases and will suit the selections already made.

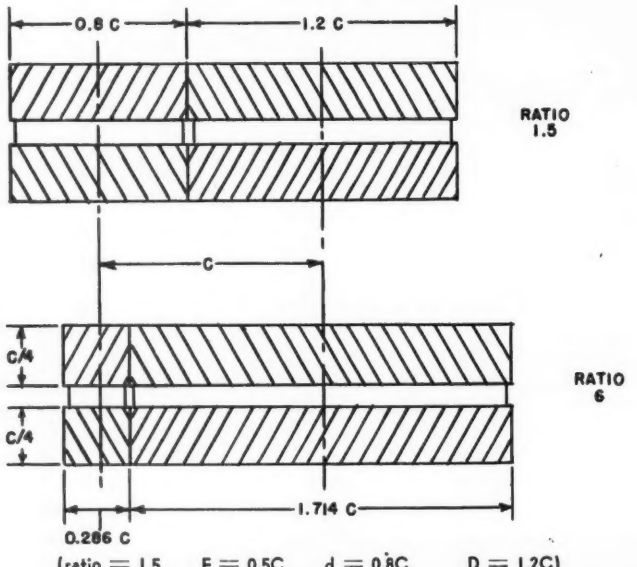


Fig. 1 A gap between the opposite-handed helixes has been provided for hob clearance; this will not be necessary if gear teeth are shaper-cut

The principal concern in gearing is tooth surface loading. The chief hazard of steel gear teeth and steel pinion teeth rolling and sliding together at high speeds with large squeezing forces is that small pits will form on the tooth at the loaded surface.

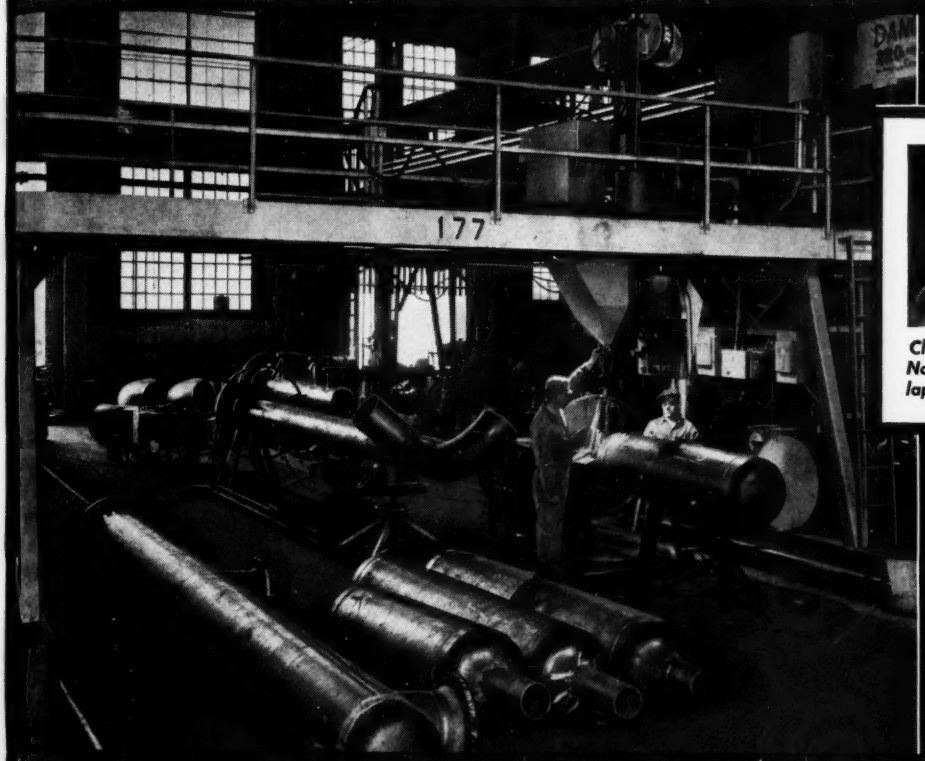
The cause of pitting is not entirely agreed upon, but the chief contribution to pitting is the sub-surface shear stresses on the tooth profiles. These shear stresses are greatly similar to the stresses set up when cylindrical rolls are pressed together lengthwise. The problem of how to calculate the stresses in cylindrical rolls was solved many years ago (by Heinrich Hertz) and can be readily converted for gear analysis to terms of pinion torque, speed ratio, face width, and center distance for any combination of materials by using this formula:

$$S_c = a \sqrt{\frac{T\,(R+1)^3}{C^2F \times R}}$$

where S_c = compressive stress at pinion tooth surface (psi)
a = constant = about 1,200,000 for steel
T = torque at pinion speed (lb-in.)
R = gear ratio = pinion speed/gear speed
C^2F — capacity constant — center distance squared times face width ($in.^3$)

The purchasers of gear sets are often confused by gear designers' constant mention of K-factor, which is merely a convenient indication of the compressive stress at the tooth

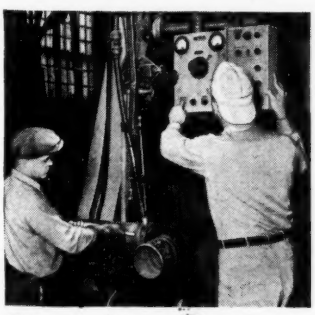
PREFABRICATED PIPING IS IMPROVED



Closeup of the weld being laid. Note smoothness of the overlapping beads.

Movable bridge transports welding head and equipment over the various work rotating machines. Operator is shown adjusting flow of flux that submerges the arc; helper cleans weld with chipping hammer as it rotates past him.

by MIDWEST MACHINE WELDING



Operator stops machine at completion of weld by simply pressing button. Push button controls position welding head exactly over work clamped in rotating machine.

Better welding is assured by this Midwest development because the "human element" has been eliminated for all practical purposes. Aside from work positioning, the operator simply starts and stops the machine; his helper chips off the slag . . . all else is automatic.

Quality of the weld is improved because the machine follows the predetermined procedure *exactly . . . everytime*. The puddle is larger and the arc is better shielded and controlled. The possibility of locking up slag is minimized while undercutting is practically impossible. The greater number of beads is a further improvement.

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surface and is proportional to the quantity under the square root sign in the above formula. With this in mind, the formula is more simply written as:

$$S_c = b\sqrt{K}$$

where the constant, b, for helical gears varies from 4300 to 6500 for the most common helix angles and pressure angles.

After deciding on a limiting contact pressure for certain applications, the gear designer can calculate the limiting K-factor immediately, but the application with its consequent limiting contact pressure must be known. The AGMA (American Gear Manufacturers Association) has issued recommendations on K-factors for many types of gear service, and most gear builders accept and use these recommendations.

The basic proportions of a gear set are thus determined by allowable tooth contact stress, torque transmitted, and gear ratio. The product, C^2F, must vary in proportion with pinion torque times $\frac{(R+1)^3}{R}$, as all the terms vary through the ranges of powers and speeds to be considered for a line of gears.

Bearing capacity is usually expressed in pounds exerted per unit of projected area, which is the product of bearing bore times active length. The pounds considered are chiefly due to the driving force on the teeth rather than the weight, except at fairly light loads. A limiting pressure of approximately 150 to 200 psi is commonly used for all sizes and speeds.

This load can be expressed as a function of the torque, center distance, and gear ratio:

$$L = \frac{T}{C}(R+1)$$

where L is the total driving load on two pinion bearings and on two gear bearings, neglected the rotor weights and the separating force component. The actual bearing force will usually be within plus or minus 15 per cent of the above value. Thus the product of projected area times allowable unit loading must be as large as the value of L, which is a function of torque, center distance, and ratio. The gear bearing sizes will generally be larger than required by loading limits in order to give more stable, conservative and better appearing proportion with the gear wheel. The additional power loss is usually insignificant.

Rating Systems

With the principles for establishing the torque and capacity of a gear set detailed, the next step is to estimate the ranges of torques and speed ratios to be handled by this hypothetical prospective line of gears. The horsepower transmitted by modern gear sets varies from fractional values to many thousands; the range from one hundred to one thousand horsepower will serve as an example, with the understanding, of course, that the same method can be extrapolated either up or down.

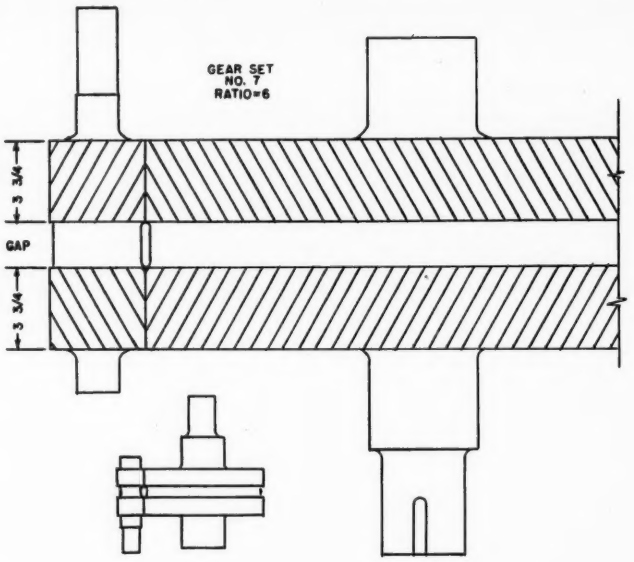

Fig. 2 Two typical sets of gears

The range of speeds involves two problems, namely speeds of driving machines and speeds of driven machines. For simplicity only speed-reducing gears will be considered here, without reducing the effectiveness of the explanation, since a gear set does not have any important characteristic differences whether it is driven by the gear or the pinion.

Most steam turbines using gears for industrial drives are usually rated at speeds from 2000 to 6000 rpm, with frequent applications requiring speeds up to 10,000 rpm. This makes a good typical example of a geared drive, so a pinion speed range of 2000 to 10,000 rpm can be used in sample calculations for the hypothetical gear set.

Gear builders' experiences have covered output speeds of a similarly large range. For planned applications of this hypothetical set to pumps, fans, generators, and industrial machinery, a range of 1000 to 3000 rpm is practical and common, although further discussion of output speeds could be endless.

The input torque range is now based upon 100 hp at 10,000 rpm (52.5 lb ft) and 1000 hp at 2000 rpm (2626 lb ft).

The range of gear ratios is not automatically settled by picking ranges of input and output speeds. In fact, there is an overlap in the area between 2000 rpm input and 3000 rpm output where using gears would not be good engineering. We can safely say that these hypothetical gears must have a ratio appreciably greater than unity, at least about 1.5.

At the same time, the maximum ratio (10,000 rpm input and 1000 rpm output) demands either a slender pinion or a watch-wheel gear. Such gear design problems can be eliminated without serious sacrifice of possible applications by setting the upper ratio limit at 6 to 1. With a lower limit of 1.5, there is a ratio range which can be covered by well-proportioned gears and pinions of reasonable size.

Since the gear ratio affects the capacity equation as $\frac{(R+1)^3}{R}$, the ratio range above will appear as 10.4 to 57.2 as it affects tooth capacity. The ratio affects bearing capacity as $(R+1)$, which will range from 2.5 to 7. To thoroughly cover all the variations in ranges at once, a formula based on earlier formulas and limiting values can be developed:

$$K \times C^2F = 6T\frac{(R+1)^3}{R}$$

For K-factor = 100 (a moderately high value), C^2F must range from 18 to 1638. Actual values for center distances and face widths will now be developed, using some more arbitrary rules which usually result in well-proportioned wheels and pinions.

Two rules which govern general design apply to the ratio of face width to pitch diameter. The smallest pinion in any of the proposed sets must have a face width not more than 2.5 times its pitch diameter; the largest gear wheel in any set must not have a pitch diameter more than 10 times its face width. Both rules apply to any gear set when the highest ratio is being used, since then the wheel diameter is greatest and the pinion diameter is least.

Applying this to this imaginary gear set, to comply with the pinion rule, the face width cannot be more

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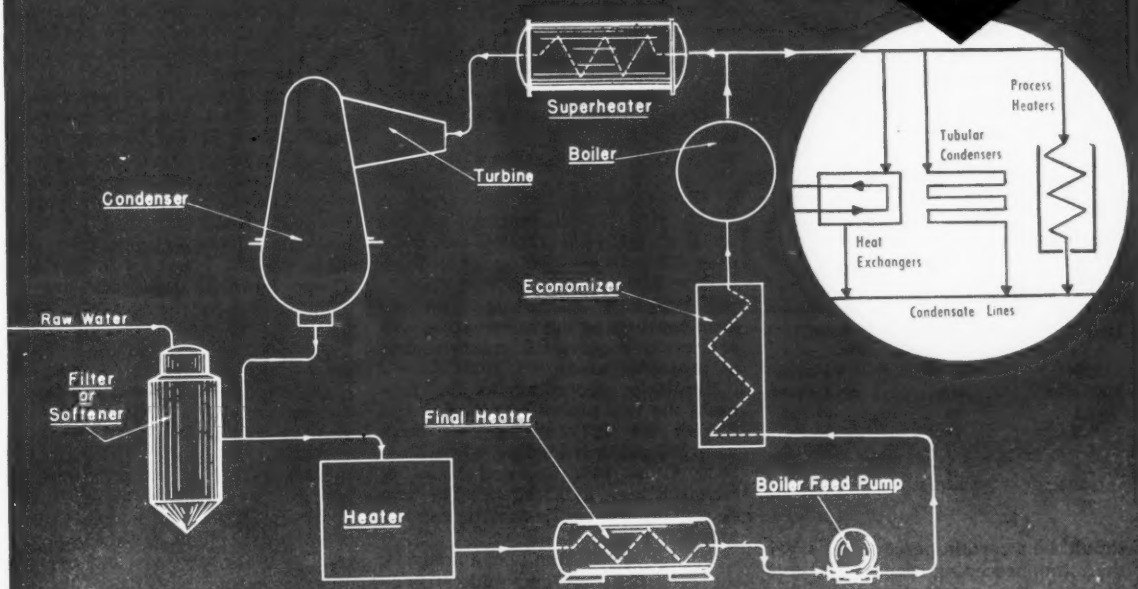

Serious production delays and high maintenance costs can result from corrosion and/or deposits occurring either in the steam condensate cycle or in the cooling water cycle of process equipment.

STEAM CONDENSATE CYCLE—Because pure water is involved, the chief difficulty encountered is corrosion, which is usually caused by a low pH condition resulting from the presence of carbon dioxide. Deposits sometimes form because of carryover or from the adherence of corrosion products. In some instances, the steam and condensate may come in direct contact with materials in process, in which case high steam purity is essential.

COOLING WATER CYCLE—Deposits are caused largely by the breakdown of carbonate hardness as the water is heated and/or concentrated. The systems involved range from simple once-through types to complex closed systems involving cooling towers and related equipment.

In order to eliminate these problems, proper water treatment must be instituted. This may range from the use of a volatile alkaline corrosion inhibitor in the steam and condensate cycle to the use of specific anti-precipitating agents and sludge conditioners in the cooling water cycle. Where steam purity is a consideration, proper boiler water treatment is necessary.

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than $2.5 \times \frac{2C}{R+1}$, or 0.713 for R = 6.

To satisfy the gear rule, the face must be at least $0.1 \times \frac{2RC}{R+1}$, or 0.171 for R = 6. This approach presents the choice of ratio-of-face width to center distance somewhere between 0.171 and 0.713, which actually means something between a narrow gear and a "skinny" pinion. For simplicity, and because it seems to work well, a face width just half the center distance will be assumed. For ratios of 1.5 and 6 the rotors will look like Fig. 1.

Rounding off the calculated values of centers and face for the C'F range from 18 to 1638, the smallest gear set will have 3⅜ in. centers and 1-11/16 in. face; the largest set will have 14¾ in centers and 7½ in face.

In order to decide on the number of sizes in the line of gear sets, reference should first be made to the principle of ratings by Preferred Numbers (See American Engineering and Industrial Standards, ASA-Z17.1—1936). Its principle is simple: each successive size or capacity

TABLE I
LINE OF GEARS WITH C'F (CAPACITY) RANGE OF 18 TO 1638

C'F Multiplier	No. of sets	Variation of K-Factor
1.2	26	69-100
1.5	12	44-100
2	7	25-100
2.4	6	18-100
—	—	—
90	2	1-100

should be a certain percentage larger than the preceding size. With this in mind, the hypothetical gear line will use the principle of the Standard, but will not use the actual Preferred Numbers recommended. One of the chief claims of this system is its tendency to unify sizes, creating uniformity and consequent interchangeability.

For multiplier = 2.0, each successive center distance will be $\sqrt[8]{2}$ or about 1.26 times its predecessor. It will be assumed that seven sizes will cover the available commercial possibilities. The K-factor for all possible choices will lie between 25 and 100, a pretty large spread.

This means that if an application is proposed which calls for a K-factor of not over 100 by AGMA standards and whose required capacity is just a shade over one of these proposed, the next larger set must be used, although its K-factor for this application is only a little more than 25. The gear not only weighs more, costs more, and takes up more space than necessary, but its losses are higher because of the larger rotors and bearings in the larger set.

All these faults are caused by the large gap in successive sizes. By reference to the table below it is evident that even a slight improvement (reduction) of this multiplier demands a huge increase in the number of standard sets. A larger number of sets calls for increased outlay of design, tools, and stock. This is one reason why some large-scale builders of gears do not carry stock items, but must build only on orders or anticipated orders. It also illustrates why two applications with only minor differences in power, speeds, or service may require different sizes of gear sets.

Since it has been assumed, for this hypothetical case, that commercial possibilities are best with seven, each twice as large as the one previous, Table II shows the rounded-off values of centers and face for each of them.

Next arises the problem of selecting bearing sizes for these seven sets. The limiting values of bearing loading, torques, center distance, and ratio:

$$\text{Load} = \frac{T}{c}$$

(R + 1) = Unit Loading × Area

The two pinion bearings in the smallest set (#1) should not have over 200 psi unit loading when T = 52.5 × 1.26, c = 3⅜ in., and R = 6; required area is 1.1 sq in. The two gear bearings at the same rating will arbitrarily require 6.6 square inches of projected area.

Similarly, according to the formula the two pinion bearings in the largest set (#7) should not have over 200 psi unit loading when T = 2626, C = 14¾ in., and R = 6; required area is 6.2 sq in. The two gear bearings will arbitrarily require 37.4 sq in.

On the basis of the above analysis, the gear bearings and pinion bearings have equal reactions and should be of equal size. Experience has shown that for general-purpose gear sets, a larger capacity should be built into the gear bearings. A large low-speed gear, if driven down by the pinion, will have its weight added to the vertical reaction, often affecting an appreciable increase.

Many applications of generator drives use a fairly heavy rotating field or armature with only one generator bearing on the outboard end, forming a three-bearing low-speed shaft. In this case, the gear shaft supports half the generator rotor, with a consequent increase in the bearing loads. Any torque disturbances originating in the driven apparatus, such as a generator short-circuit or torque fluctuations in a pump or compressor, will be more

TABLE II

Set No.	Center Distance	Face	C'F
1	3⅜	1 11/16 in.	19.2
2	4¼	2⅛ in.	38.4
3	5½	2¾ in.	83.1
4	7	3½ in.	171.5
5	9	4½ in.	365
6	11½	5¾ in.	760
7	14¾	7½ in.	1640

TABLE III

Set No.	Centers	Face	C'F	Pinion Brgs.	Gear Brgs.
1	3⅜	1 11/16	19.2	1x¾	2x1½
2	4¼	2⅛	38.4	1x¾	3x2
3	5½	2¾	83.1	1½x1	3x2
4	7	3½	171.5	1½x1	4x3
5	9	4½	365	2x1½	4x3
6	11½	5¾	760	2x1½	5x4
7	14¾	7½	1640	2x1½	5x4

apparent in the low-speed shaft than in the high-speed shaft, because of the absorbing flywheel effect of the gear wheel. This requires a larger shaft diameter through the journals, indirectly increasing the bearing size. All in all, experience has shown that it is good engineering to design the gear bearings partly by calculation and partly by appearance.

To proportion the journals, a check should be made of the twisting stresses at the limiting torque values before settling on diameter. For 5000 psi shear stress, the pinion shaft diameters must be at least 0.2 in for set No. 1 and 0.6 in for No. 7; gear shaft diameters must be at least 0.2 in for No. 1 and 1.4 in for No. 7. These limiting diameters are not large enough for the necessary bending stiffness, and are considerably less than the smallest pinion pitch diameters for each set. Apparently, therefore, the unit bearing loading determines the bearing size, and gives a safe twisting stress in the journals.

As a result of computations explained previously, Table III now gives the essential dimensions of a complete line of general purpose gear sets. Seven sizes of gear casings, six sizes of bearings, six sizes of shaft seals, and a few sizes of inspection covers, lifting hooks, vapor vents, oil piping, and other accessories can be designed to equip them. Figure 2 shows two typical sets of the above series.

MONTEITH VICE PRESIDENT IN CHARGE OF ENGINEERING AT WESTINGHOUSE

A. C. MONTEITH, 46-year-old engineering executive of the Westinghouse Electric Corp. has been elected vice president in charge of engineering and research, Gwilym A. Price, Westinghouse president, announced from Pittsburgh. He succeeds Marvin W. Smith whose election as executive vice president of Baldwin Locomotive Works was announced.

Mr. Monteith joined Westinghouse in 1923 as a graduate student engineer in the training course, and was assigned to the central station engineering department in 1924. He became manager of that department in 1938 and in 1941 was named manager of the industry engineering department.

In 1945, he became manager of headquarters engineering departments and director of education.

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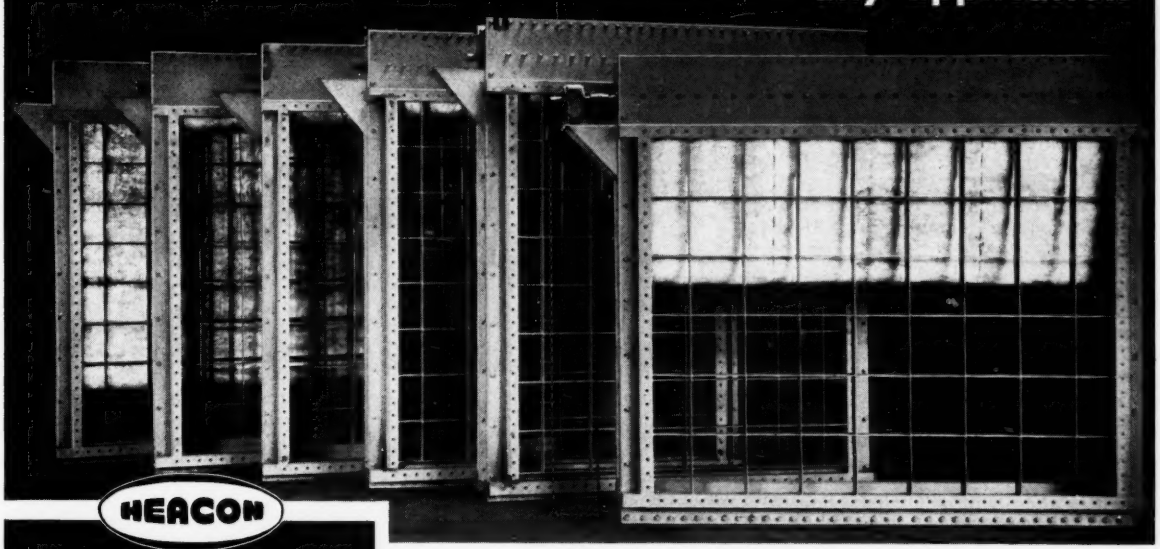

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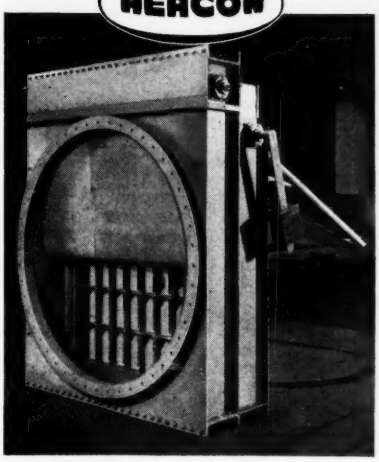

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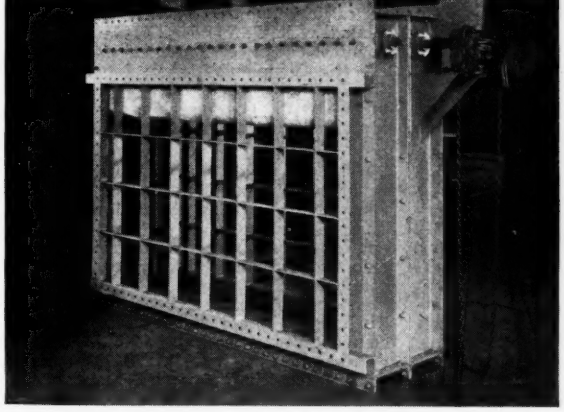
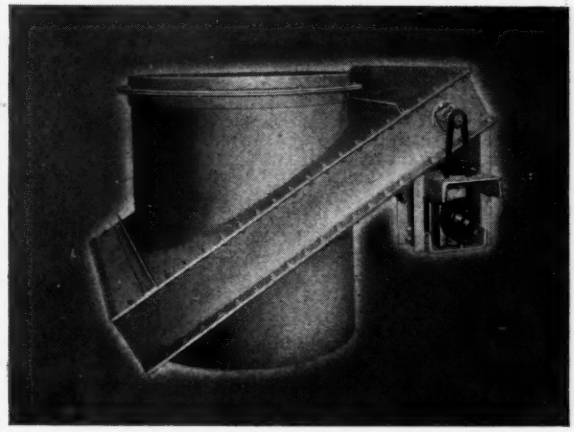


SIV—inclined type Damper for vertical duct downward flow.



18th New York Power Show to Feature Power Plant Economies

AT THE 18th National Exposition of Power and Mechanical Engineering, to be held at Grand Central Palace, New York, November 29th to December 4th, 1948, a long list of innovations designed to improve the performance of power plants will be featured.

Among the new developments which visitors at the exposition will see is a 2,000-hp fluid drive pumping unit capable of pumping a million pounds of water an hour into a high-pressure boiler. Another exhibit will feature a new type of steam turbine centrifugal boiler feed pump. An improved method of removing tramp from coal will be demonstrated; while a number of engineering improvements have greatly improved the performance of various well-known spreader stokers.

With smoke prevention coming into critical regard in many communities, there will be shown a new Robot-Eye combustion control that automatically regulates the fuel-air ratio in smaller and medium-sized heavy oil fired boilers, designed to yield an efficiency said to be comparable with that of larger plants, yet without the danger of forming smoke. With a thought for the exigencies of the fuel situation, there will also be an exhibit of a package-type steam generator arranged with provision for quick change-over between light and heavy oil and gas fuels.

Other exhibits will include the extension of the packaged equipment idea, to compressor units, especially adaptable to the needs of smaller industrial plants and designed to be of special interest to food packers and laundries; also a display of what is claimed to be "the only two-speed portable electric blower manufactured". A brand new portable all-electric steam cleaner, especially designed for economical plant maintenance, will be featured.

An improved condenser will be offered by a well-known specialist in industrial air conditioning; while a new application for synchronous electric timers will make its bow in a device that provides automatically for the periodic cleaning of electrostatic air filters.

Of scientific as well as economic significance is a recently developed method for sterilizing water without the aid of either heat or chemicals and without imparting an unpleasant flavor or odor.

New economies will be demonstrated in designs of piping and valves, such as a new line of forged steel valves for low pressure drop with improved packing features; all purpose small globe valves; new gate valves; a motor-operated pressure seal non-return valve.

In the long line of new instruments already assured for the exposition are: a new pyrometer; a multiple recorder that traces four lines on a chart simultaneously; and several newly developed methods of automatic pH control.

The exposition will be held during the same week as the 1948 Annual Meeting of the American Society of Mechanical Engineers.

Tentative Program Annual ASME Meeting, 1948

FIVE DAYS filled with important technical papers on all phases of mechanical engineering; stimulating discussion of the engineer's place in industry and society; research in fundamental mechanical engineering; and solutions of practical mechanical engineering problems are promised when the American Society of Mechanical Engineers holds its 1948 Annual Meeting at the Pennsylvania Hotel, New York City, from November 28 to December 3.

The keynote luncheon on Monday, November 28, will feature the place of the engineer in management.

Highlights of the program of particular interest to power engineers are given below. At this writing the program is still tentative.

MONDAY, NOVEMBER 29

9:30 a.m. Heat Transfer (I)

The Mechanical Cleaning of Fouled Heat Exchanger Tubes, by Alexander John, Jr., assistant general manager, Thomas C. Wilson, Inc., Long Island City, New York.

Chemical Cleaning of Heat Exchange Equipment, by C. M. Loucks, district chemist, Dowel, Inc., Cleveland, Ohio, and C. H. Groom, development engineer, Dowell, Inc., Tulsa, Okla.

12:15 p.m. Keynote Luncheon

Opportunity for and Responsibility to the Young Graduate Engineer in Industry, by L. A. Appley, president, American Management Association, New York, N. Y.

2:30 p.m. Hydraulic (II)

Elements of Graphical Solution of Water Hammer Problems in Centrifugal Pump Systems, by A. J. Stepanoff, development engineer, Ingersoll Rand Co., Phillipsburg, N. J.

2:30 p.m. Gas Turbine Power (I)—Machine Design (I)—Applied Mechanics (II)

Mechanical Investigations of Gas Turbine Components, by Carl Schabtach, staff assistant to manager of engineering, apparatus department, General Electric Co., Schenectady, N. Y.

Current Design Practices for Gas Turbine Power Elements, by H. D. Emmert, Jr., engineer-in-charge, turbo-power development department, research section, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

8:15 p.m. Heat Transfer (III)

Panel Discussion

Nature of Deposits, by L. F. Collins, Detroit Edison Co., Detroit, Mich.

Problems in Steam Power Plants, by W. L. Webb, mechanical engineering division, American Gas & Electric Service Corp., New York, N. Y.

Problems in Marine Power Plants, by C. V. Hawk, commander, U.S.N., Bureau of Ships, Navy Department, Washington, D. C.

Fouling and Cleaning Problems Pertaining to Process Industries, by R. L. Clapper, head of service department, Griscom-Russell Co., New York, N. Y.

Influence of Fouling on Design of Heat Exchangers, by R. M. Armstrong, manager of heat transfer division, Downingtown Iron Works, Downingtown, Pa.

8:15 p.m. Gas Turbine Power (II)—Fuels (I)—Power (I)

Gas Turbine Locomotive Units—Combustion Chamber Development for Burning Heavy Oil, by B. O. Buckland, engineer, and D. C. Berkey, turbine-generator engineering division, General Electric Co., Schenectady, N. Y.

Effects of Fuel Properties on the Performance of the Turbine Engine Combuster, by L. C. Gibbons, National Advisory Committee for Aeronautics, Washington, D. C.

The Cooling of Gas Turbines Operating at High Inlet Gas Temperatures, by O. W. Schey, chief of the compressor and turbine research division, National Advisory Committee for Aeronautics, Washington, D. C.

TUESDAY, NOVEMBER 30

9:30 a.m. Hydraulic (III)

Chairman: J. F. Roberts, Mgr., Hydraulic Div., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Recorder: L. J. Hooper, Prof., Alden Hydraulic Lab., Worcester Polytechnic Inst., Worcester, Mass.

Repairs to Hydro Adjustable Blade Turbines by Welding, by Joel D. Justin, consulting engineer, Justin & Courtney, Philadelphia, Pa., and E. T. Davis, mechanical engineer, Indiana Michigan Electric Company, Mishawaka. Ind.

Cavitation, by R. T. Knapp, professor of hydraulic engineering, California Institute of Technology, Pasadena, Calif.

9:30 a.m. Gas Turbine Power (III)

A 5000-KW Gas Turbine for Power Generation, by Alan Howard, division engineer, and C. J. Walker, section engineer, gas turbine engineering division, General Electric Company, Schenectady, N. Y.

Results of Tests on a Locomotive Gas Turbine Unit, by Alan Howard, division engineer, gas turbine engineering division, and B. O. Buckland, engineer, General Electric Company, Schenectady, N. Y.

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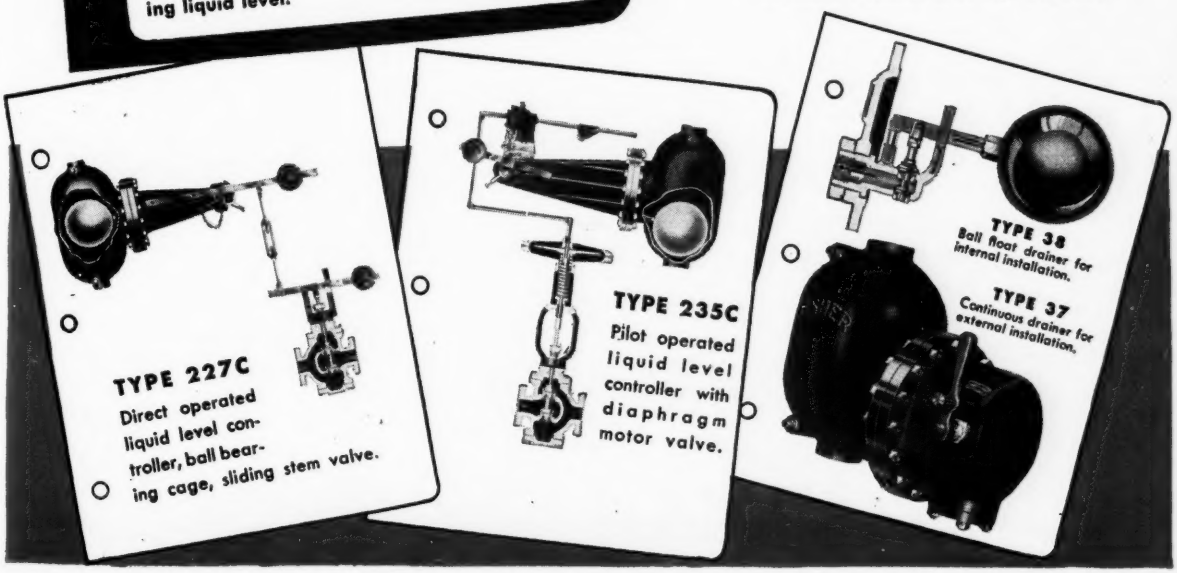

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Direct operated liquid level controller, ball bearing cage, sliding stem valve.

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Ball float drainer for internal installation.

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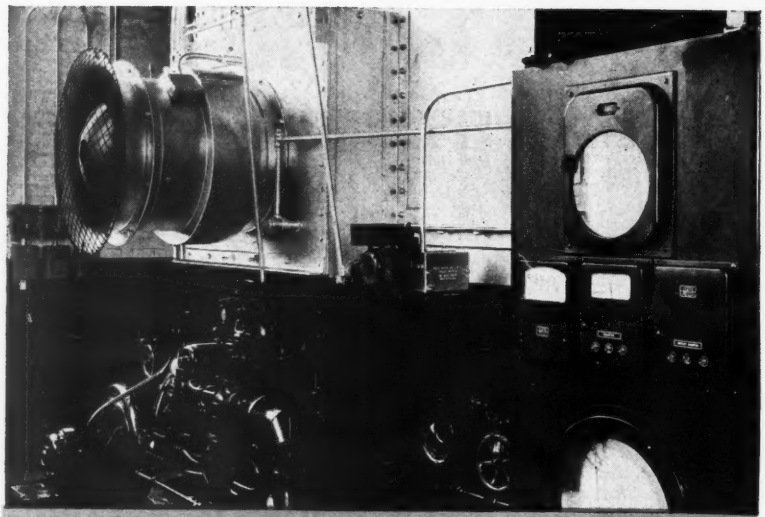

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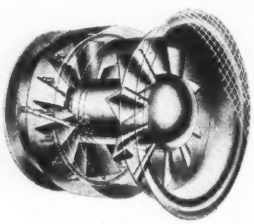

Wing EMD Blower showing simple design and built-in volume control. Internal radial dampers are actuated by an external balanced lever. Can be adjusted manually or by combustion controls.

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AXIAL FLOW BLOWERS

9:30 a.m. Heat Transfer (IV)
Cooling Tower Analysis, by Joseph Lichtenstein, consulting engineer, Foster Wheeler Corporation, New York, N. Y.

12:15 p.m. Power Luncheon
Utility and Industrial Cooperation in Generation and Use of Steam and Electricity, by Joseph Pope, vice-president, Stone & Webster Engineering Corp., New York, N. Y.

3:00 p.m. Power (III)—Applied Mechanics (V)—Gas Turbine Power (IV)
Power Plant Cycle Evaluation, by J. K. Salisbury, division engineer, thermal power systems division, General Engineering and Consulting Laboratory, General Electric Co., Schenectady, N. Y.

6:00 p.m. Gas Turbine Power Dinner
The Gas Turbine's Place in the World Power Field, by Walker Cisler, executive vice-president, Detroit Edison Company, Detroit, Mich.

8:15 p.m. Petroleum (II) — Machine Design (IV)
Plain Bearings—Today and Tomorrow, by Edwin Crankshaw, assistant chief engineer, Cleveland Graphite Bronze Company, Cleveland, Ohio.
Babbitting Methods for Bearings.

8:15 p.m. Engineers Civic Responsibility Committee Town Hall Broadcast

WEDNESDAY, DECEMBER 1

9:30 a.m. Power (V)
Operating Experiences in Connection with Regenerative Reheat Turbine Installations, by C. A. Robertson, engineer, steam turbine department, Allis-Chalmers Manufacturing Co., West Allis, Wis.
Developments in Resuperheating in Steam Power Plants, by E. W. Harris, assistant division engineer, and A. O. White, section engineer, turbine engineering division, General Electric Co., Schenectady, N. Y.
Steam Turbines for Reheat Cycle, by E. E. Parker, division engineer, steam turbine and generator engineering division, General Electric Co., Schenectady, N. Y.
Reheating in Steam Turbines, by R. L. Reynolds, manager, central station turbine section, Westinghouse Electric Corp., Lester, Pa.

12:15 p.m. IIRD Luncheon
12:15 p.m. Fuels Luncheon
Synthetic Liquid Fuel Research, by W. C. Schroeder, chief, synthetic fuels branch, U. S. Bureau of Mines, Washington, D. C.

2:30 p.m. Power (VI)
Steam Generating Equipment for Resuperheating Cycles, by Martin Frisch, vice-president in charge of engineering, Foster-Wheeler Corporation, New York.
High Pressure Boilers with Reheaters, by W. H. Rowand, chief engineer, Babcock & Wilcox Company, New York, N. Y.

2:30 p.m. Fuels (IV)
Combustion Ash Collection for the Small Power Plant, by Philip F. Best, chief mechanical engineer, The Thermix Corp., Greenwich, Conn.
How to Cut Small Boiler-Plant Costs by Mechanical Coal and Ash Handling, by C. E. Miller, technical advisor, H. M. Carlson, research engineer, and R. B. Engdahl, supervisor, Battelle Memorial Institute, Columbus, Ohio.
Studies on Flyash Erosion, by M. A. Fisher, and E. F. Davis, Institute of Gas

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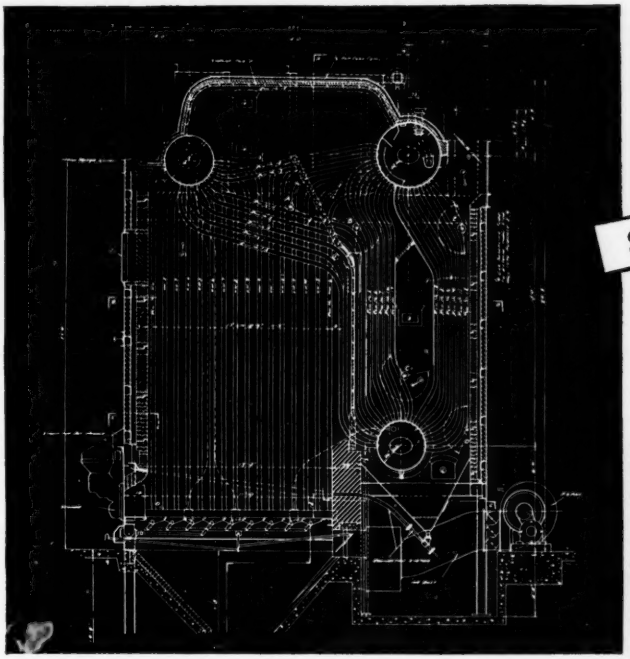

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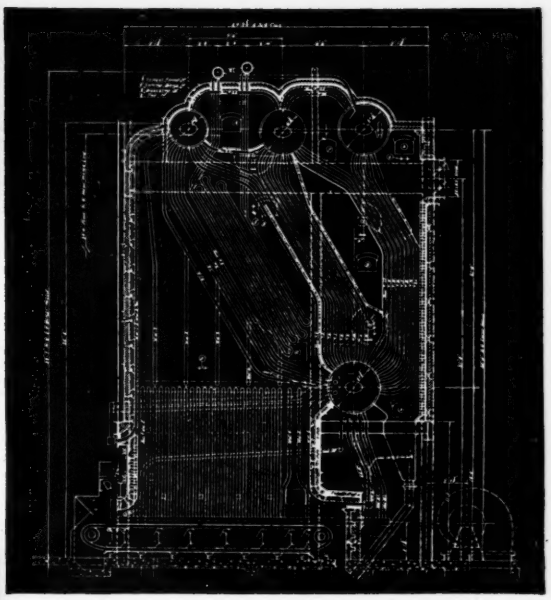

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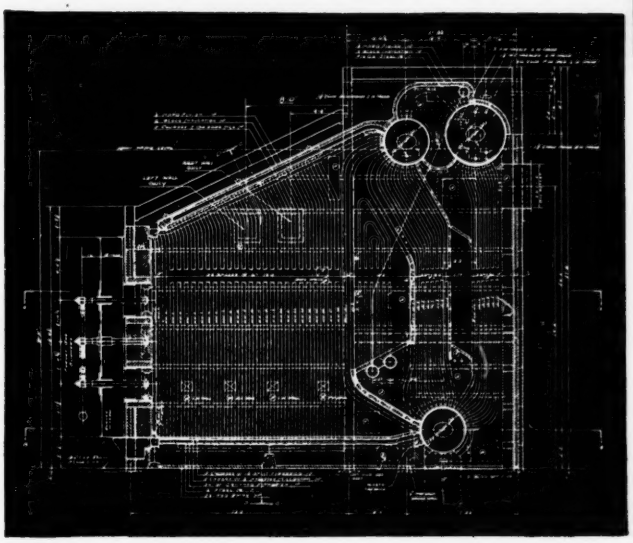
CLASS LE — Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR — 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



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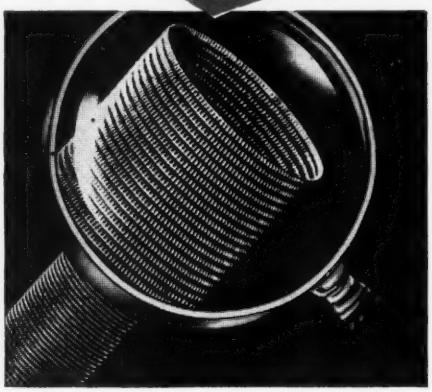

- A good strainer protects your equipment and pipelines. The most important part of a strainer is the screen.
- *Screens* used in Yarway Strainers are made of high-grade monel woven wire having small triangular openings fine enough for required stoppage of dirt, rust and scale, but having ample free area for passage of clean condensate, oil or other fluids. Mechanical strength is greater than ordinary mesh. Perforated screens if desired.
- *Screen cap* is made with straight thread, machined face and spark-plug-type gasket, insuring tight joint. Screen comes out with cap for easy cleaning... automatically aligns when replaced.
- Iron and steel bodies of Yarway Strainers are cadmium-plated for protection against corrosion and better appearance.
- Six sizes, ½" to 2". Hundreds of thousands in use. Stocked and sold by 150 Mill Supply Dealers. See your local supply house or write for Bulletin S-201.

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YARWAY STRAINERS
"Police the Pipelines"

Technology, Armour Research Foundation, Chicago, Ill.

6:30 p.m. Annual Dinner and Honors Night

THURSDAY, DECEMBER 2

2:00 p.m. Boiler Feedwater Studies (I)—Power (VII)

Corrosion of Boiler Generating Tubes at Battersea and Deptford West Generating Stations, by R. Ll. Rees and E. A. Howes, London Power Co., Battersea Generating Station, Battersea, England.

Hydrogen Embrittlement of Heat-Transfer Surfaces in Power Boilers, by E. P. Partridge, director of research, Hall Laboratories, Inc., Pittsburgh, Pa.

Corrosion Erosion of Boiler Feed Pumps and Regulating Valves at Marysville, Second Test Program, by H. A. Wagner, chief mechanical engineer, engineering division, J. M. Decker, research engineer, and J. C. Marsh, technical engineer, Detroit Edison Co., Detroit, Mich.

8:15 p.m. Safety—Boiler Code Committee

A Survey of Typical Boiler and Machinery Accidents, by G. P. Wieman, manager, boiler and machinery division, National Bureau of Casualty Underwriters, New York, N. Y.

Cause Analysis of Boiler and Machinery Accidents, by H. W. Heinrich, assistant superintendent, engineering and inspection division, Travelers Insurance Co., Hartford, Conn.

FRIDAY, DECEMBER 3

9:30 a.m. Furnace Performance Factors—Power (IX)—Fuels (VI)

Southwark Station Boiler Air Flow Model Tests and Operation Results, by R. A. Lane, engineer, mechanical engineering division, Philadelphia Electric Co., Philadelphia, Pa., and E. L. Morrison, staff engineering department, Babcock & Wilcox Co., New York, N. Y. Instrumentation for Furnace Testing. Report on the Fundamental Process of Tube Wastage.

COMING EVENTS

N.E.C.—National Electronics Conference to be held at the Edgewater Beach Hotel, Chicago, November 4-6.

AIEE—Southern District Meeting to be held at the Tutwiler Hotel, Birmingham, Alabama, November 3-5.

ASME—The annual meeting of the American Society of Mechanical Engineers to be held at the Hotel Pennsylvania and New Yorker, New York, November 28-December 3.

Power Show—18th National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace, New York, November 29 to December 4.

SESA—The Annual Meeting of the Society for Experimental Stress Analysis will be held at the Hotel Commodore, New York, December 2-4.

AIEE—Conference on Electric Welding to be held in Detroit, December 6-8.

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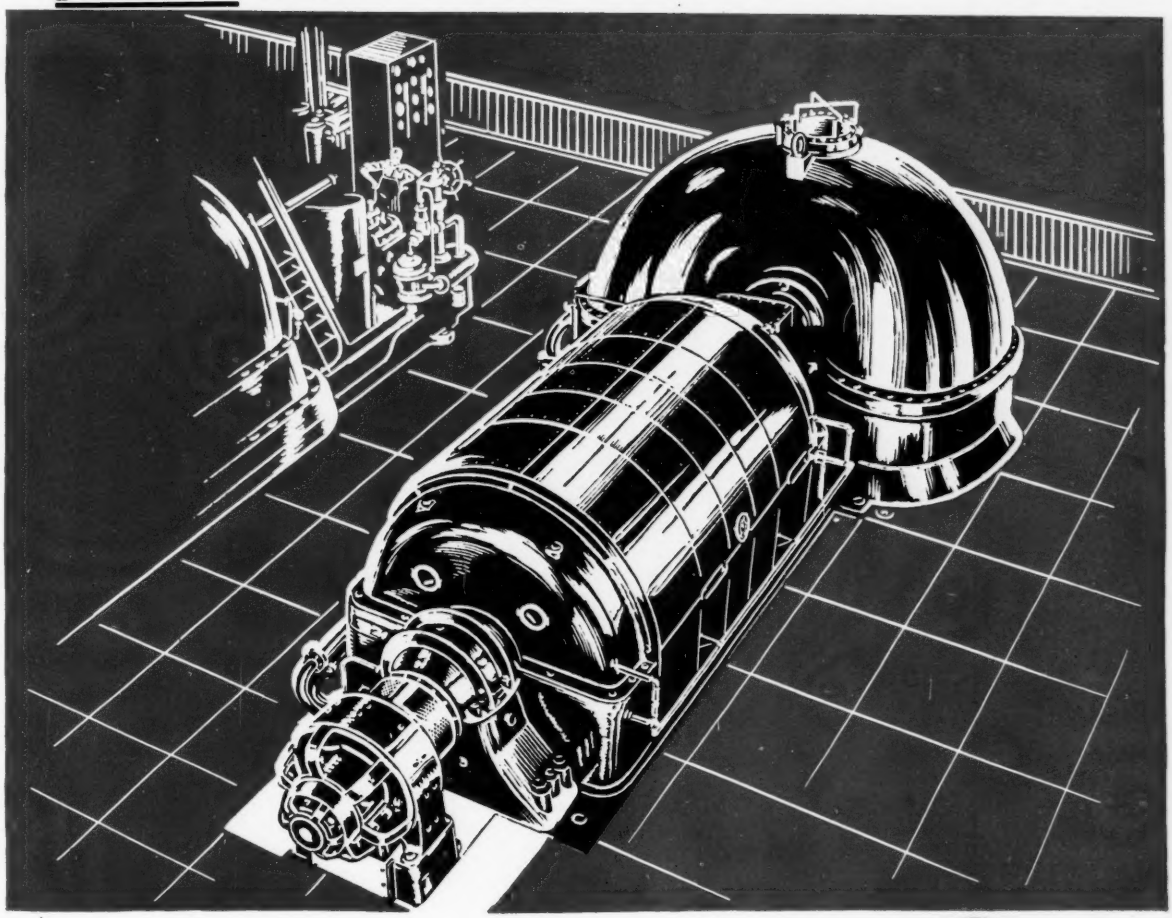

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. . . *Tycol Aturbrio Oils* have a purity of refinement . . . service endurance . . . high rust and oxidation inhibiting qualities that combine to make an ideal turbine lubricant.

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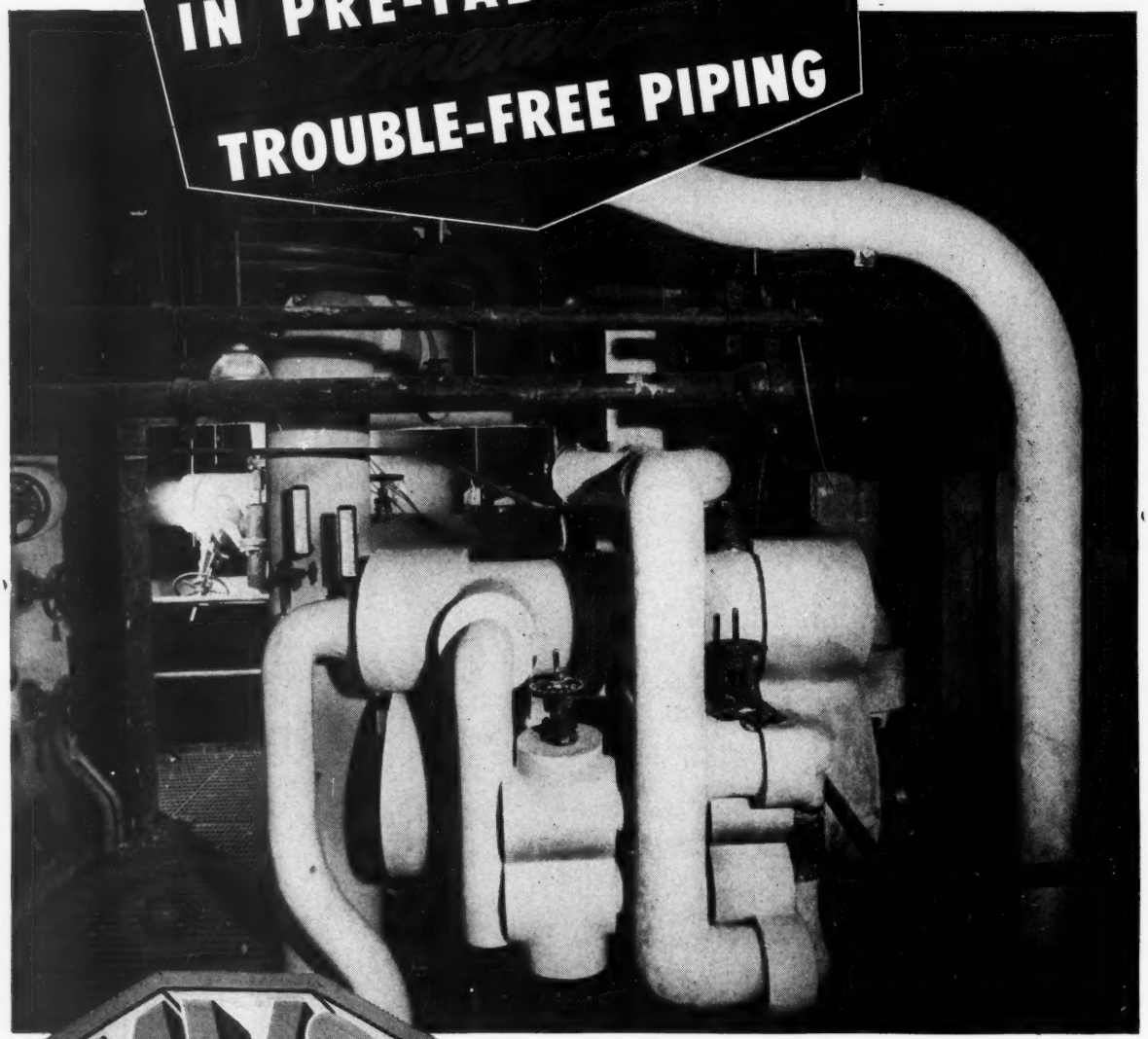

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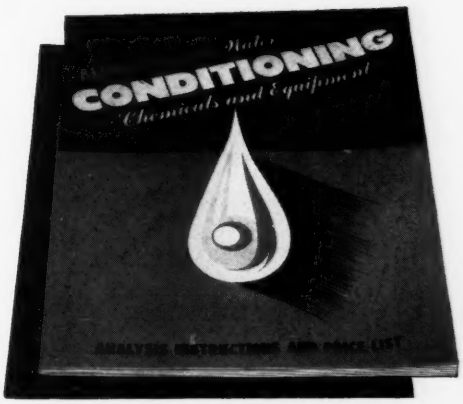

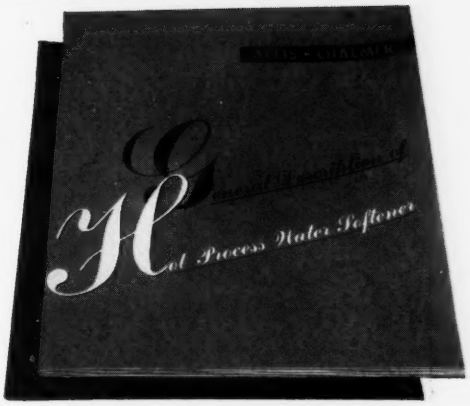

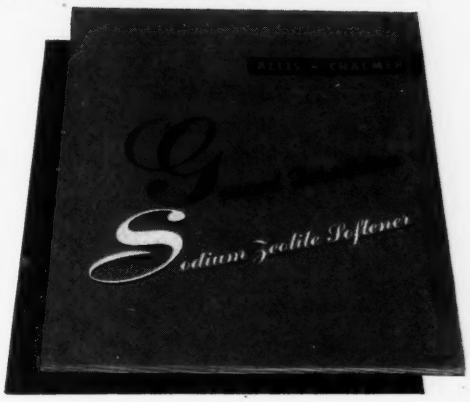

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- ☐ 7107 Sodium Zeolite Softeners

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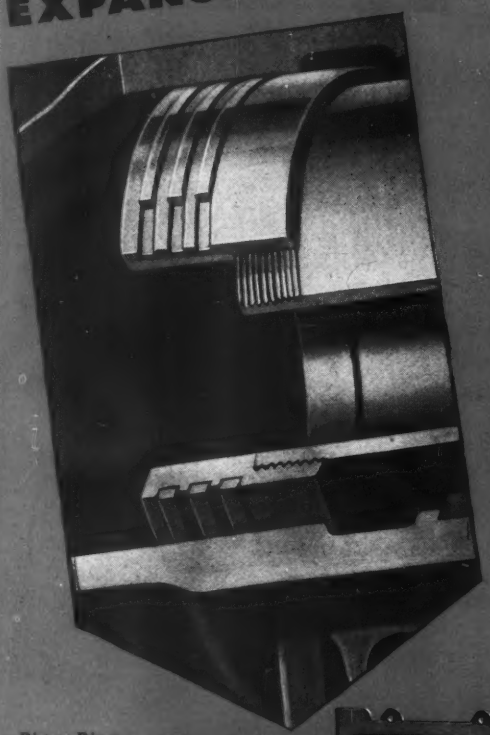

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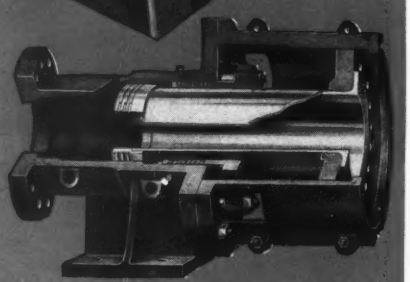

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PROPOSED RAILROAD TRAIN for non-stop, coast-to-coast service, has recently been designed by C. D. Gibbs and A. Milnamow and details of it have been presented to a number of railroads, with the idea that here is one way by which the railroads might regain some of the long-distance travel they have been losing to their chief competitor, the airplane. The airlines have constantly been 'way ahead in utilizing the latest mechanical and scientific improvements, while the railroads have lagged for economic reasons. The railroads are handicapped by fixed rates and extremely high costs. At present, it seems that only by starting an entirely new type of service, one requiring filing and application for new rates with the ICC, could a satisfactory revenue be obtained.

This new type of service, according to Mr. Gibbs, might consist of a non-stop run at high speed with additional comfort. For such service a different type of railroad train would be necessary. Mr. Gibbs proposes such a train, made up of unit cars, each 100 feet long, drawn by a locomotive containing a high pressure turbine generating plant. The locomotive would contain two oil fired boilers delivering steam at 700 psi, 835 F to a turbine generator exhausting to an air-cooled condenser. Suitable auxiliaries, such as geared auxiliary generators, Diesel auxiliary units, and the like, would be provided. The turbine would operate at constant speed and the generators would supply power to driving motors on the axles.

Since the train would make no stops between points such as New York and Los Angeles, the train crew would have to be carried on board, in sufficient numbers for the required number of shifts, and would have their own special car. The whole organization of the train would be much more like that of a ship than of the present train.

A train of this kind might consist of the locomotive, one crew car, one service car, 5 roomette cars, one dining car, 5 room cars, one stateroom car and one recreation car. Each car would be 100 ft long with special construction, such as roller bearings and new types of connections between cars to eliminate jerking and pounding. Car bodies would be insulated and air conditioned. Each car would carry its own water supply and air conditioning system, would have intercar and external telephone and radio communication.

The various railroads concerned would have to insure rights of way for such a high-speed train crossing the continent, and some changes in track might be necessary.

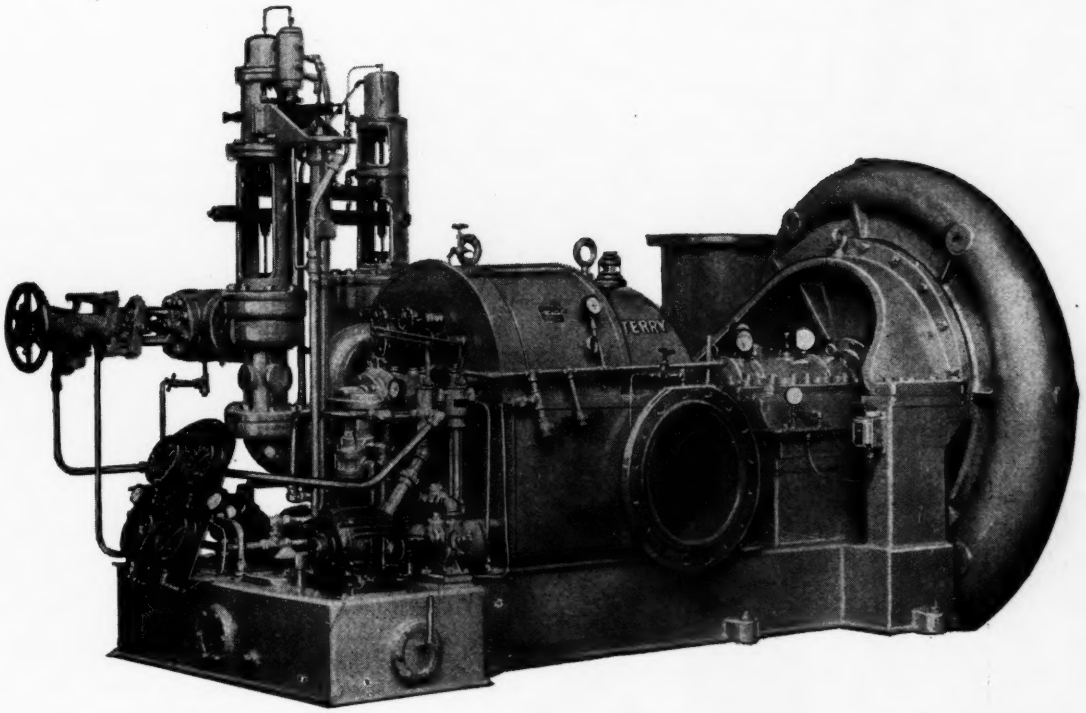
The railroads at each end would have to provide terminals with train platforms 1700 ft long, provisions for turning the train around, for refueling and restocking it.

Under normal conditions of weather and with the proper right of way across the country, the average speeds of the train might be between 80 and 110 miles per hour. Temperature would have an important effect on the turbine steam consumption and hence on the speed.

On the above basis, the running time for such a train on an average run of 3270 miles, at 82 miles per hour, would be 39.9 hours.

It is estimated that such a train would cost a total of about $4,000,000 to build; that with two trips a week each train's revenue per year would be $2,550,000; and that the net earnings per year would be $1,250,000. On the basis of these costs, the charge for the service might have to be about 5 cents per mile.

The TERRY TURBINE



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. . . and the speed under any of these conditions can be varied from 2800 to 4750 rpm.

This is but one example of many unusual combinations developed by Terry to meet out-of-the-ordinary requirements in turbines up to 2000 hp. Information on a special-purpose turbine for your specific requirements will be gladly furnished.

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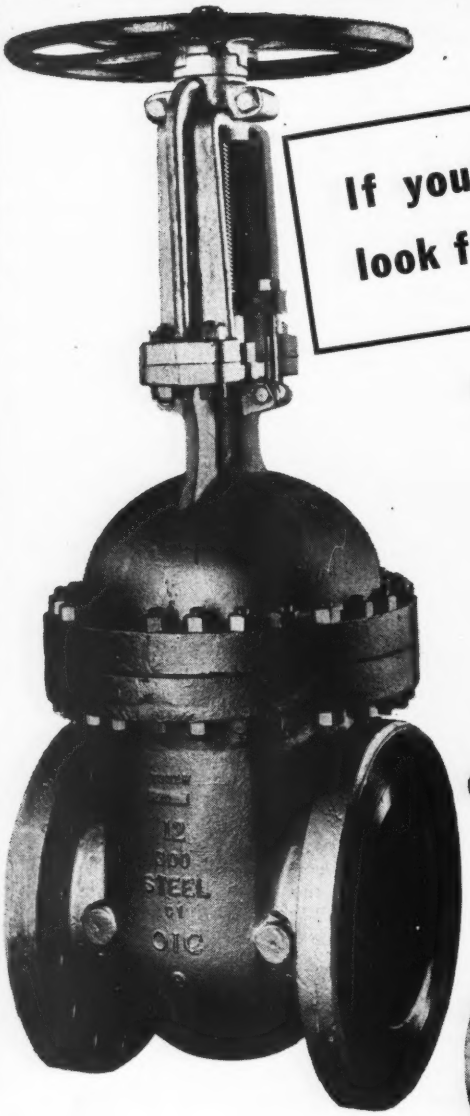

These stock valves, made to serve in all types of pipe lines, are standard with seats of hard, corrosion-resistant cast "S"* MONEL, to insure longer service life with minimum maintenance. Made by Ohio Injector Company, Wadsworth, Ohio.

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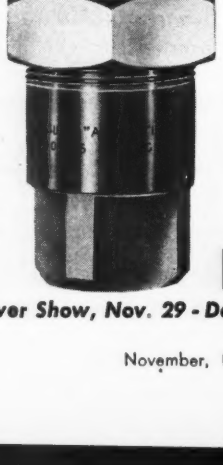

George Automatic Steam Drain Valves are designed for locomotive and steam plant service. The body of this valve is heat-treated "KR" MONEL, operating-spring is cold-drawn MONEL, and the conical closure disk is Type 303 18-8 Stainless Steel. Made by George Manufacturing Company, Phila., Pa.

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MONEL valves and valve parts can give you improved performance in 4 important ways:

1. Fewer mechanical failures. MONEL's exceptional strength, which exceeds that of structural steel, can minimize failures caused by overstressing seats, stems, and other working parts.

2. Less erosion and abrasion wear. Because of its superior hardness, MONEL can substantially reduce damage caused by turbulence, flow erosion, and particle abrasion. With heat-treatable "K"* and "KR"* MONEL, a degree of hardness can be obtained that greatly exceeds that of other non-ferrous alloys. This feature, alone, can sometimes extend valve life by a large percentage.

3. Fewer corrosion worries. Being rust-proof and corrosion resistant, even at high temperatures, MONEL can greatly extend the service life of valves operated under severely corrosive conditions. With fewer replacements and repairs required, valve maintenance costs can be kept to a minimum.

4. Fewer failures caused by heat. MONEL has good heat-resistant qualities, and is satisfactory for service up to 800° F. MONEL is oxidation resistant, and does not embrittle even under continuous high-temperature conditions.

It is because of this remarkable combination of properties that MONEL has been chosen by so many leading valve makers as an industrial "task" metal. You'll find MONEL in many types of fine valves . . . valves designed to give you *extra* service with *minimum* maintenance.

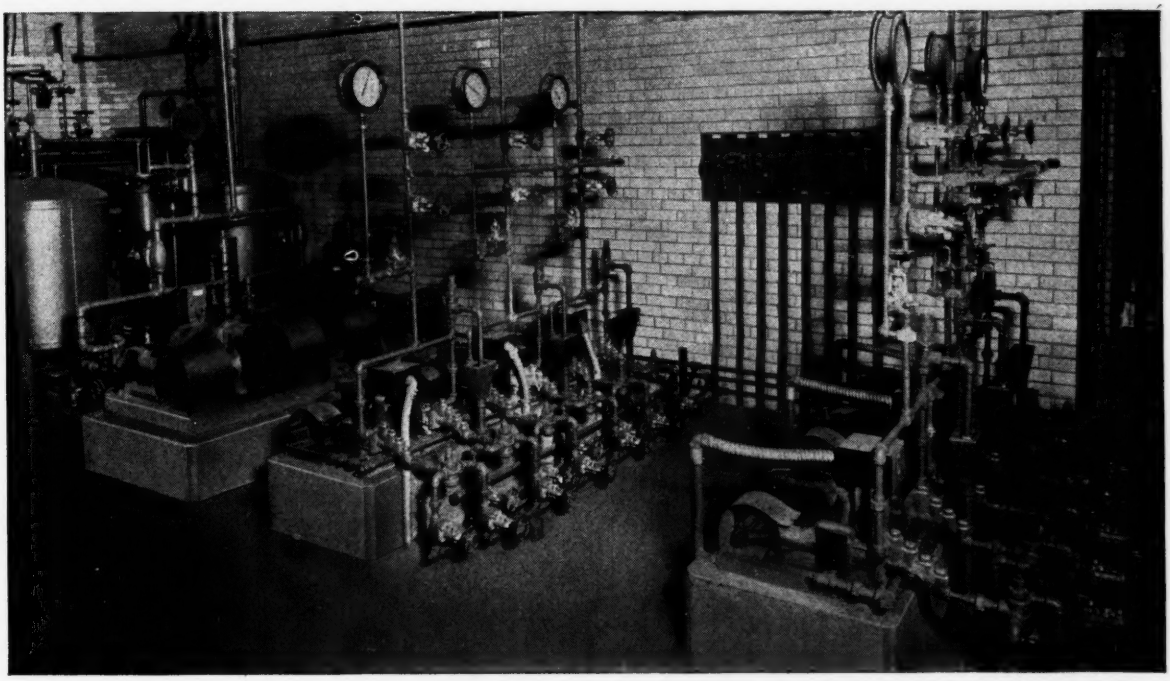
If you would like more information about MONEL as a valve material, write to Bob Johnson, in care of the International Nickel Company. He will be glad to supply you with engineering data and dependable sources of supply. *Reg. U. S. Pat. Off.

EMBLEM OF SERVICE INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

MONEL...*for minimum maintenance*

Visit Us At The Power Show, Nov. 29 - Dec. 4, Booths 8 and 9, Grand Central Palace, New York City.



FOR BOILER WATER CHEMICAL TREATMENTS

Specify • Milton Roy Chemical Pumps
• Milton Roy Chemical Feed Systems

Proof of "Performance" in chemically treating boiler water are the many installations of Milton Roy equipment in modern utility and industrial power plants . . . both complete Milton Roy "Packaged" Systems engineered for specific applications and Chemical Pumps as components in systems developed by plant engineers. In the plants listed below typical installations of such equipment have been made in recent months.

SPRINGS COTTON MILLS, GRACE, S. C. (Complete packaged systems, including tanks and accessories, for handling both sulfite and phosphate feeds.)

ESSEX (NEWARK) GENERATING STATION, PUBLIC SERVICE ELECTRIC & GAS CO. (Pumps.)

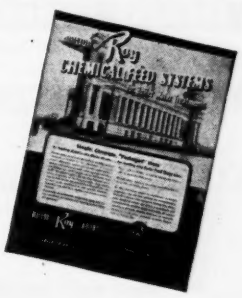
LANSING (MICH.) STATION, INTERSTATE POWER CO. (Pumps and tanks for feeding sulfite and phosphate.)

EAGLE POINT WORKS, TEXAS CO., WESTVILLE, N.J. (Pumps.)

MANSFIELD TIRE & RUBBER CO., MANSFIELD, OHIO (Pumps.)

SOUTHWARK STATION, PHILADELPHIA ELECTRIC CO. (Packaged systems, for feeding sulfite and phosphate. Shown above.)

Milton Roy Packaged Systems include all necessary pumps, solution tanks, covers, gage glasses, low level cutouts, alarms and motor starters. They can be supplied with automatic electronic controls to operate pumps at speeds proportional to feed water flow as measured by a flow meter. Available to handle all treating chemicals and in capacities to meet all pressure and capacity requirements.



Details in Bulletin 451 . . . ask also for Technical Paper 51 "What the Power Engineer Needs to Know About Chemical Feed Systems."

MILTON Roy COMPANY

MILTON THE EXCLUSIVE STEP VALVE DESIGN

1320 E. MERMAID LANE, CHESTNUT HILL, PHILA. 18, PA.

DARTS are leak-proof because of the ground ball joint

BECAUSE OF THE TRUE BALL JOINT . . spherically-ground to form wide, true-bearing surfaces . . . Darts are tight without jamming. Seats remain unscarred and true . . . ready for repeat use.

BECAUSE OF THE TWO BRONZE SEATS a Dart resists pitting, electrolysis and corrosion . . . gives years of leak-proof service.

BECAUSE OF THE HEAVY SHOULDERS a Dart shrugs off wrench abuse through dozens of installations.

BECAUSE OF THE TOUGH BODY . . made of practically indestructible air-refined malleable iron . . . a Dart has highest resistance to stress and stretching.

These extra-quality features explain why Darts are the lifetime union . . . why Darts can be used again and again.

E. M. DART MANUFACTURING CO.
PROVIDENCE 5, RHODE ISLAND

DART
UNIONS

STREAM POLLUTION

(Continued from page 61)

ditional headache to the problems of plant production and something to be resented or to be given as little time and attention as was necessary to "get by" with the demands of enforcement officials.

If this has been your viewpoint, let me urge you to think of pollution abatement or waste treatment as being as integral a part of the production of your product as the raw materials and labor which go into it. Look at the disposal of your wastes from the standpoint of those who use the stream below *your* mill; from the standpoint of those who would like to use it for *their* water supply or for recreation, including fishing. Look at it from the standpoint of reducing and abating your pollution and of trying to find a use for your mill wastes, not primarily from the standpoint of profit making. If you don't, a rising public demand will help you to such a viewpoint.

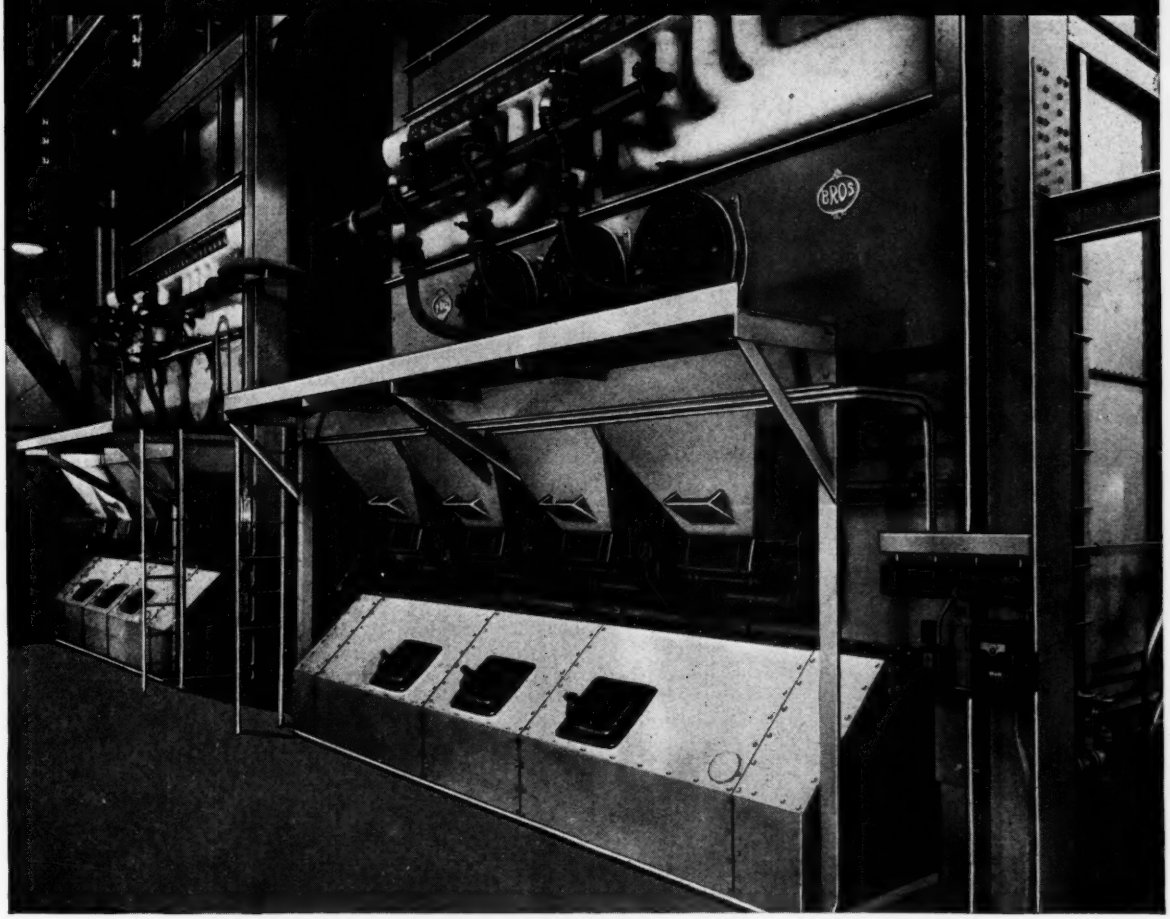
It will very frequently, be of great help to you to employ an engineer skilled in waste treatment as the consultant or designer of the treatment works while you collaborate with him in fitting the principles of waste treatment into your process requirements and, in particular, to the limitations of your own plant. The two of you working together may very well evolve changes in processes, or rerouting of works, segregation of wastes, or re-use of waters, or other economies which neither alone would develop.

It is surprising how woefully inadequate the data supplied by a mill management often are, both as to the quantities and qualities of the wastes; and how frequently the information which is supplied is based on only a few determinations which may not be representative or may lack essential data as to rates, times, and other important matters. For many plants, months may be required to secure the necessary data. So don't forget to measure and analyze accurately and sufficiently.

Then, too, remember that good housekeeping pays, in a mill as well as in a home. Great sums of money can be saved by reducing the volume and strength of waste waters by separating polluting wastes from clean waters, such as clean cooling waters, thereby cutting down on the size of treatment works; by recirculating waters where practical; and by other measures which can be taken within the mill before true waste treatment begins..

About two thirds of all undeveloped water resources in the United States were on the Pacific Coast and one fifth in the northeastern and southeastern states before the war, says a Twentieth Century Fund survey.

One furnace...three fuels



SWITCH TO COAL, OIL OR GAS IN A MATTER OF MINUTES

● *Bros* engineers have achieved this remarkable new fuel flexibility by designing a steam generating unit fired by *Bros Travl-Spred* continuous ash discharge spreader stokers and combination gas and oil burners.

This is *Bros'* answer to today's critical problem of fuel availability. And it can free you, as a manufacturer, from the imminent threat of short supply—whether it be coal, oil or gas. For with this *one* furnace, you can use *three* fuels—and switch from one to the other easily, simply, in a matter of minutes!

In the installation pictured (B. F. Nelson Mfg. Co., Minneapolis), these two *Bros* 90,000 lb. combination units supply continuous power and process steam for the manufacture of roofing paper.

But whatever you manufacture, you can eliminate costly shut-downs due to fuel availability problems just as the B. F. Nelson Mfg. Co. has. The first step is a letter to Wm. Bros Boiler and Mfg. Co., Minneapolis, Minnesota, for complete specifications and details on this new *Bros* Combination Unit.

BROS

WATER TUBE, FIRE TUBE BOILERS • OVER FEED, UNDER FEED • HYDRAULIC-TRAVL-SPRED STOKERS

TROY-ENGBERG
STEAM ENGINE

SAVE
BY USING
BY-PRODUCT POWER

Make your STEAM do two big jobs . . . eventually one of them at little or no cost. With proper heat balance your steam can provide—FIRST, power for driving equipment, and SECOND, heat units needed for processing or heating.

Use boiler steam to run a Troy-Engberg Steam Engine. THEN use the exhaust in your heating or processing lines. Drive your pumps, stokers, generators, blowers or compressors with By-Product Power. Use a Troy-Engberg Steam Engine as a reducing valve and your power cost saving will pay for the engine in a very short time.

Send for Bulletin 306

TROY ENGINE & MACHINE COMPANY
Established 1870
2100 Railroad Avenue Troy, Pennsylvania

TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

COOLING TOWERS

(Continued from page 70)

if not, inspection should be made more often.

How to Maintain the Filling

Function of the filling is to increase the contact between air and water, primarily by offering new exposed surface to the air as the water cascades through the tower. Another function is to maintain proper distribution of both air and water. Its efficiency is affected by oil, dirt, algae and the like, and it is, therefore, important to keep the filling clean. Filling composed of flat horizontal slats is more subject to collection of foreign matter than decks composed of vertical or sloping slats. Sagging filling tends to concentrate the water in the areas of the low spots of the fill. This in turn, causes air channeling, since the air will not so readily pass through areas of high water concentration as through areas of low water concentration. This air channelling reduces the contact between air and water; thereby reducing the performance.

Types of filling, in general, fall into two classes; the grid type and the slotted lath type.

Grid Type Filling:—The grid type consists of boards or battens nailed on cleats to form panels. These panels or grids are usually substantial enough to function as scaffolding during erection, and are convenient to walk on when cleaning and inspecting the tower. The grids are easily removed and are substantial enough to be cleaned with a fire hose.

Slotted Lath Filling:—This consists of slotted lath, through which are threaded other lath. This type of filling is not nailed and should not be walked upon. It also cannot be readily removed, nor should it be cleaned with a fire hose.

Oil in the cooling tower water is detrimental to tower performance, because the oil soaked filling will not be wetted by the water. This results in improper breakup of the water and reduction in wetted surface exposed to the airstream. Oil deposits have been removed from filling by solvents and steam. However, it is usually cheaper to replace the filling.

Algae growth probably contributes more to reducing the performance of cooling towers than any other factor. Once algae has made headway, there is very little to do but to shut down the tower and do a thorough cleaning job. This is usually accomplished by means of a fire hose and/or circulating a strong chemical solution. This should be immediately followed by a flushing and draining of the entire cooling system, to prevent fouling of the heat exchanger surface by the dead algae.

How to Maintain Cooling Tower Basins

Cooling tower basins are usually built of concrete, but are also made of redwood and steel.

Occasionally the water circulated

Important points to know about COTTRELL *Electrical Precipitators*

A COTTRELL Electrical Precipitator is a major plant investment. Once installed it is operated over a period of many years, *thus multiplying year after year the benefits of top notch design and installation.*

And because of the many factors affecting the operating and collecting efficiency of a COTTRELL Precipitator, probably in no other field do the experience and "know-how" of the organization designing and installing the unit play a more important role in influencing the overall performance of the installation. That is why it is so important to remember this fact . . .

Western Precipitation Corporation is the organization that installed the first successful COTTRELL *Precipitator over 39 years ago, still operating efficiently . . . and has consistently developed new refinements, new techniques, new applications that today have made it world famous in the science of recovering dusts, fly ash, mists, fogs and other suspensions from gases.*

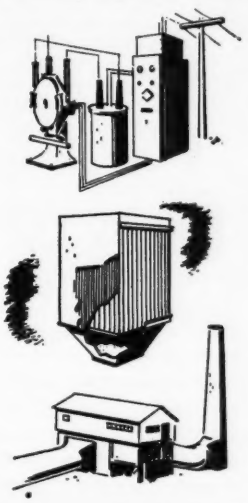
This is the first of a series of advertisements briefly outlining the important elements that go to make up a COTTRELL installation. Only long experience coupled with highest engineering ability, can assure the proper combination of these elements into a COTTRELL installation best suited to *your particular requirements*!

Basically, a Cottrell Precipitator consists of three major divisions each in turn consisting of many separate elements . . .

1. THE ENERGIZING SYSTEM, as its name implies, is the portion of the unit wherein the power is brought in, the voltage stepped up, then rectified to provide the unidirectional high voltage current supply for the Electrode System.

2. THE ELECTRODE SYSTEM consists of the high-tension ionizing electrodes and collecting electrodes through which the suspension-laden gas is passed to be cleaned. These electrodes can be of various designs, shapes and patterns and are equipped with various "rapper" arrangements which assist in keeping the electrodes clean of recovered materials.

3. THE HOUSING OR SHELL includes the structure containing the Electrode and Energizing Systems as well as the gas ducts and distributing system, the hoppers for receiving the collected material and other miscellaneous equipment.



Each of these three major divisions, together with their many individual parts, must be carefully engineered into ONE integrated and precisely-balanced unit to provide the successful and continuously-operating COTTRELL Precipitator. This series will take these major units apart to show in greater detail how the individual parts function and the varying types of design and construction. Watch for them.

10 COTTRELL ADVANTAGES

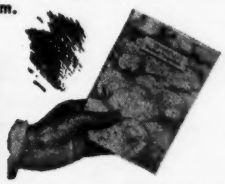
that make Cottrells unsurpassed for all types of recovery problems, hot or cold, wet or dry

1. **LOWEST DRAFT LOSS** — only a few tenths of an inch w. g.
2. **LOWEST POWER COST** — only ½ to 1 kwh. per 100,000 cu. ft. of gas cleaned.
3. **LOWEST MAINTENANCE COST** — all metal, few moving parts, no fire hazard.
4. **LOWEST LABOR COST** — operation can be fully automatic, if desired.
5. **LONGEST LIFE** — early Cottrell installations still operating after 39 years of continuous service.
6. **HIGHEST EFFICIENCY** — recovery efficiency approaches 100%, if desired.
7. **UNIVERSAL APPLICABILITY** — recover any suspension, solid or liquid — in any gas — over wide temperature ranges.
8. **ANY CAPACITY** — handle a few c.f.m. — or millions — with equal ease.
9. **MAXIMUM FLEXIBILITY** — readily adaptable to varying installation requirements.
10. **LOWEST OVERALL COST** — cost less per year of service, less per ton recovered. Often pay for themselves in a few months — always within a few years.

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1029 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 LoSALLE ST. BLDG., 1 N. La SALLE ST., CHICAGO 2 • HOBART BUILDING, SAN FRANCISCO 4, CALIFORNIA
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL



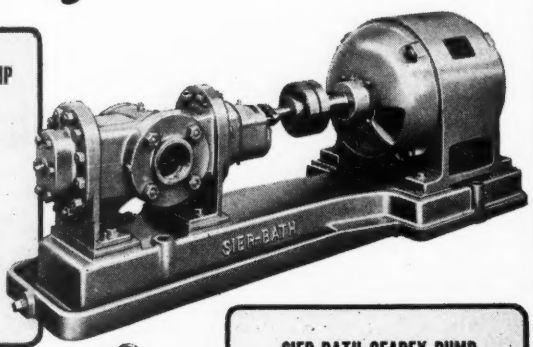
Do You Have This Helpful COTTRELL Booklet? In 28 pages of interesting charts, illustrations and descriptive data, it answers many of the questions engineers ask about COTTRELL design and construction. Send for your free copy. Ask for Bulletin C103!

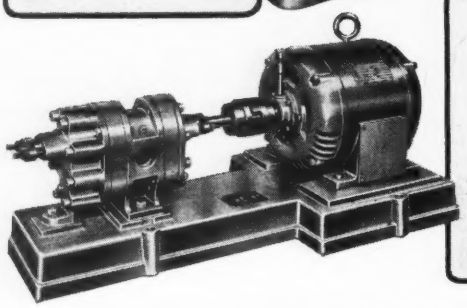
ONE PUMP working on the job is *worth a dozen* in the repair shop!

SIER-BATH SCREW PUMP

Advantages: • pulseless flow • anti-friction bearings • vibrationless operation • low maintenance cost • rugged construction.

Pumps: Acetate, asphalts, brines, Bunker C Fuel Oil, Cellulosics, Greases, Molasses, Syrups, Lube Oils, etc.





SIER-BATH GEAREX PUMP

• Balanced Axial Thrust • Pulseless Flow • Vibrationless Operation • Roller Bushings for Precision Running under load.

Pumps: Oils, Varnishes, Solvents, Molasses, Chemical Solutions.

Capacities: 1-550 g. p. m.

Discharge: 250 p. s. i. for medium or high viscosities. 50 p. s. i. for water.

The most notable point about SIER-BATH Screw Pumps and Gearex Pumps is their relative freedom from maintenance.

THERE is no mystery about the ability of Sier-Bath Pumps to stand up under the most trying conditions. After all, in such pumps, the worms and gears are the most important parts. And when you consider that Sier-Bath Pumps are made in the best equipped precision gear shop in the country, it is easy to understand their exceptional dependability. Their pulseless flow and vibrationless operation greatly reduce maintenance cost—there is much less wear on valves, couplings and other fittings. Pipes and joints remain tight. With labor costs at their present high figures, these are important points to consider in pump selection. Send for descriptive booklet.

ALSO MAKERS OF SIER-BATH PRECISION GEARS

FOUNDED 1905 **MEMBER A. G. M. A.**

Sier-Bath
GEAR and PUMP CO., Inc.

9256 HUDSON BOULEVARD • NORTH BERGEN, NEW JERSEY

in the tower will have a detrimental effect on the concrete basin; in such cases, it has helped to plaster the basin with an asphaltic base material similar to roof putty.

When cooling tower basins are constructed of redwood, it is difficult to maintain a water-tight basin. This is particularly true when a tower is used seasonally, as in connection with an air-conditioning system. A redwood basin should never be allowed to dry out, for if redwood dries and shrinks, and then soaks and swells, the wood will never quite revert to its former dimension. If this cycle is repeated very many times, the basin will no longer be water-tight. This is also true of redwood stave pipe, often used as a primary distributing header. It should not be allowed to dry out; also, the reinforcing bands should be kept tight to prevent leakage.

One of the best ways of stopping a redwood basin from dripping is to add shredded asbestos, similar to the fibrous insulating material used in plastering fractionating columns, to the area of the basin containing the leak. This fibrous material will then migrate to the area of the leak and will flow into and seal the crevice.

Suction pit screens should be incorporated in all cooling-tower basins. They strain extraneous matter out of the cooling system, and do much to reduce the maintenance of the circulatory system.

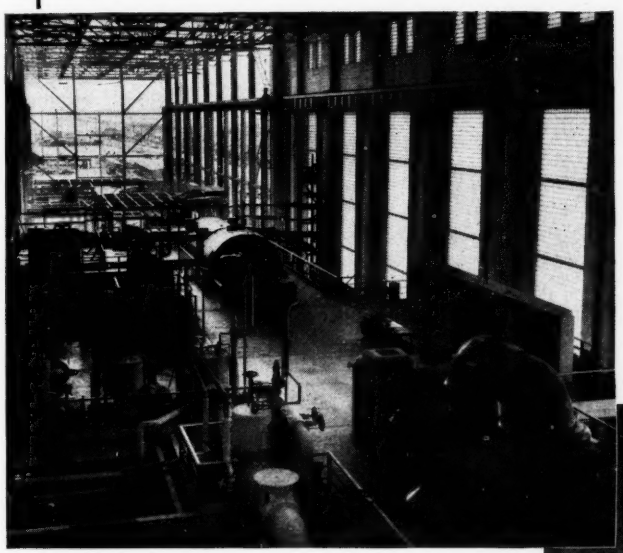
An attempt should always be made to keep the water level in the basin above the level of the anchor bolts and anchor castings. The interfacial surface between the air and water has been found to be very corrosive. Inspection shows accelerated corrosion to occur at the water line when very little, if any, occurs above and below this point.

Maintaining Mechanical Equipment

Because failure of any part of the mechanical equipment (such as the fan, gears, or flexible coupling and floating shaft) will shut down the unit, it is important that a regular inspection and maintenance program be adopted. Here is a minimum service schedule for the various pieces of apparatus.

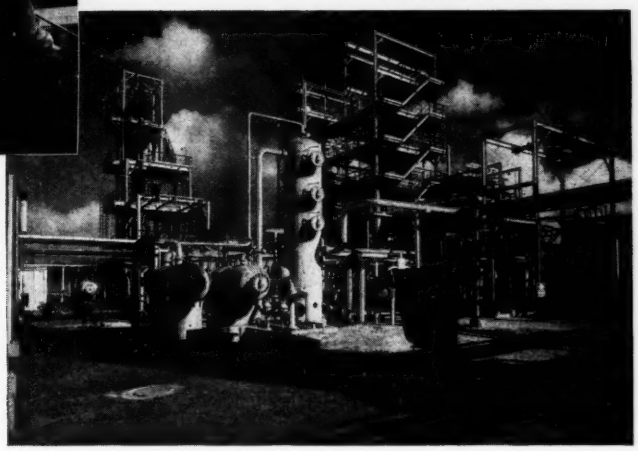
Gear:—Oil level in the gear should be checked every 30 days. If the level has gone down, the gear case and oil seals should be checked for leaks, and appropriate steps taken to stop them. On the other hand, if the oil level appears to have risen, drain a one-quart sample from the bottom of the gear case and check it for emulsification and contamination. Because the gear on an induced-draft tower is located in a hot, humid, air stream, moisture may condense in the gear case. This is particularly true in towers operated intermittently. If there are any signs of emulsification, the oil should be drained and replaced with the type of lubricant recommended by the

THE Common denominator



Interior view of First Section of new Redondo Steam Station of Southern California Edison Company, now under construction at Redondo Beach, California.

Crude Alcohol Unit of the Esso Standard Oil Company's Refinery at Baton Rouge, Louisiana.



Experience is the common denominator which is essential to the success of any project, large or small. The many years of experience of Stone & Webster Engineering Corporation in engineering, design and construction covers a wide range of diversified projects.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

No other tube cleaner could do it!

★ The engineer of an upstate New York university power plant with five large boilers tried every known make of tube cleaner, including our old Roto. He didn't think any of them "worth a hoot" for removing his rock-like scale.

★ When we developed the new ROTOJET, we sent him our Model 525 for field test. He was so amazed and tickled with the way this powerful new cleaner performed that he insisted on buying it. He said it was the first cleaner that ever cleaned his tubes properly, and that "it made a tough job seem ridiculously easy."

★ No tube cleaner built during our 38 years of specialization in this field can even remotely compare with the new ROTOJET for power, efficiency, and cleaning speed. A single cleaning job with a ROTOJET will prove that you can't afford to use any other tube cleaner.

Send for new bulletin

ELLIOTT COMPANY-ROTO DIVISION
147 Sussex Avenue Newark 1, N. J.

manufacturer. An inspection should also be made of the oil seals, particularly the one on the slow-speed shaft. Since oil seals are normally inserted in a small recess in the housing, it collects the moisture condensed on the fan shaft. Any failure of the seal, or corrosion on the shaft at this point, will permit the collected water to enter the unit.

An oil sample should be drained from the bottom of the gear case every three months. Again, if the oil shows any sign of emulsification, contamination, or deterioration, it should be drained and replaced. Oil should be drained and refilled every six months with the exact type of lubricant recommended by the manufacturer.

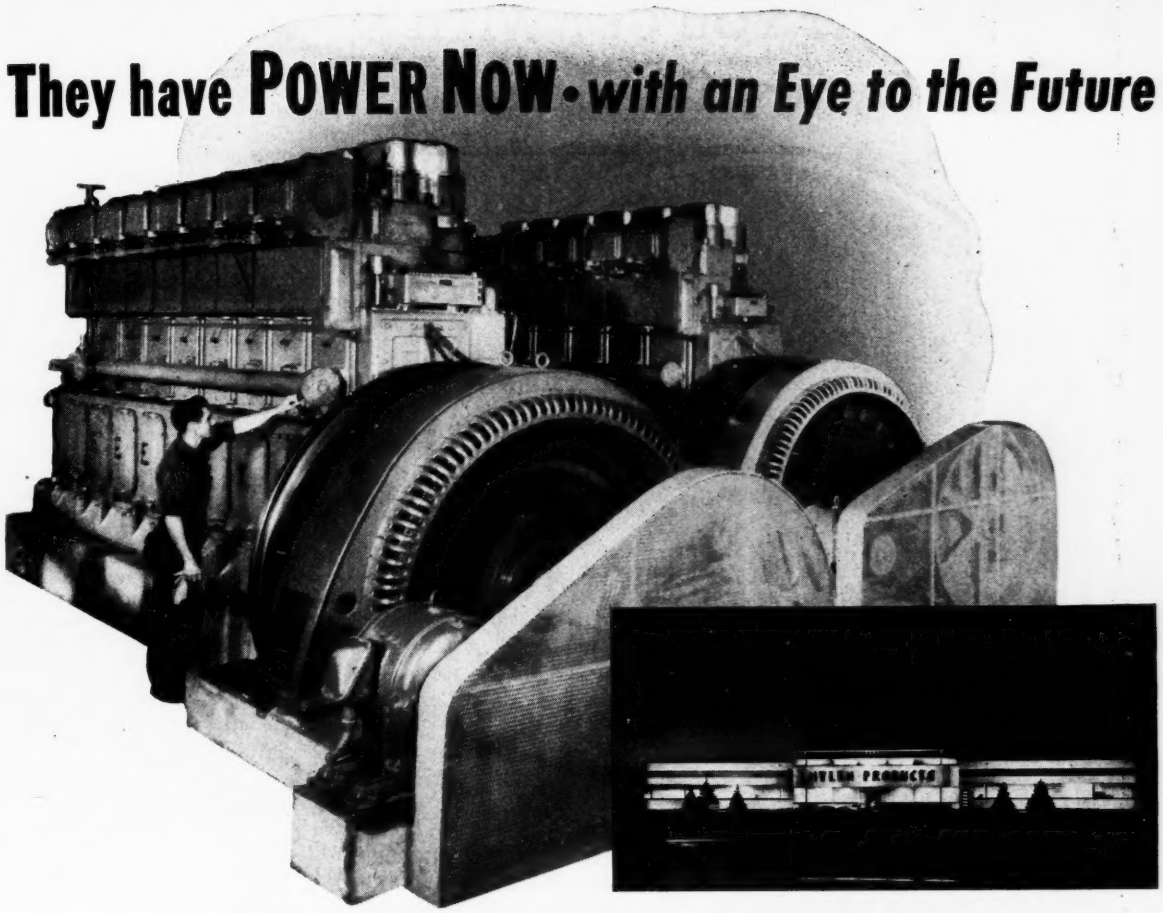
Once a year, examine the oil seals on the gear and replace if necessary. Also, check the bearings for play, particularly the bearings on the fan shaft, where the greatest wear usually occurs. This can easily be checked by rocking the fan blade up and down. If any appreciable wear has occurred, the bearings should be either adjusted or replaced. Where oil is found to be emulsified in the gear unit, indication of excessive wear will usually be found on the lower slow-speed shaft bearing. This is because, on some reducer designs, sufficient sump capacity for collecting water and sludge is not provided below the lower main bearing. If this condition exists, some relief can be obtained by substituting a large capped reducing nipple for the drain plug in the center of the gear case, thus allowing room below the bearing for the water to settle.

Couplings: — Floating shaft couplings used on cooling towers are: gear types, metal, fabric or rubber disk type, and coupling should be

The gear type coupling should be taken apart and inspected once a year. The lubricant, together with any contaminates, should be drained and discarded. The teeth on the coupling should be washed with kerosene and examined for wear before reassembling. Care should be taken in the choice of a lubricant for this gear type coupling since it operates in a hot, humid air stream and there is danger of moisture condensing inside. As moisture condenses, the centrifugal action of the revolving coupling causes the water to displace the lubricant in the periphery of the housing. Since the gear teeth are also located on the housing periphery, serious wear may occur because of lack of lubrication. Because of this it is recommended that the lubricant used be of the water proof type whose specific gravity is greater than that of water.

The disk type coupling should be examined every six months for cracks and breaks in the fabric or metal discs. Should they show any signs of wear, the disks should be immediately replaced. It is recom-

They have POWER NOW · with an Eye to the Future



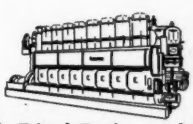
Why Nylen Products Co. installed 2 ENTERPRISE DIESELS in its St. Joseph, Michigan plant

Nylen Products Company manufactures precision equipment for the great automotive and refrigeration industries. All power for running Nylen's extensive operations is supplied by their own diesel electric generating plant. Needless to say, this power *must* be continuous, adequate—completely dependable.

Aside from installing more power *now,* however, Nylen had the problem of selecting units which could later be converted to provide even *greater* KW output. Enterprise diesel engineers had the answer to this problem in two engines specially designed for quick conversion to turbocharging at any time in the future. This includes such turbocharged equipment as enlarged water, lube oil and fuel oil pumps, air intake connections, oversized waste heat boilers. The Enterprise DSQ-8 now develops 700 KW non-turbocharged, is direct connected to an over size generator capable of delivering 1125 KW when the diesel is eventually turbocharged. A similar rate of stepped-up output is also available with the conversion of the smaller DSQ-6. Conversion time and trouble are minimized through the special design features.

Whatever your power problem, it will pay you to ask us to show you the many advantages and improvements in power application available in Enterprise Diesels.

Choice of Power Experts . . . Everywhere



4 Cycle Diesel Engines and Generating Sets up to 1800 HP per unit, turbocharged or normally aspirated.

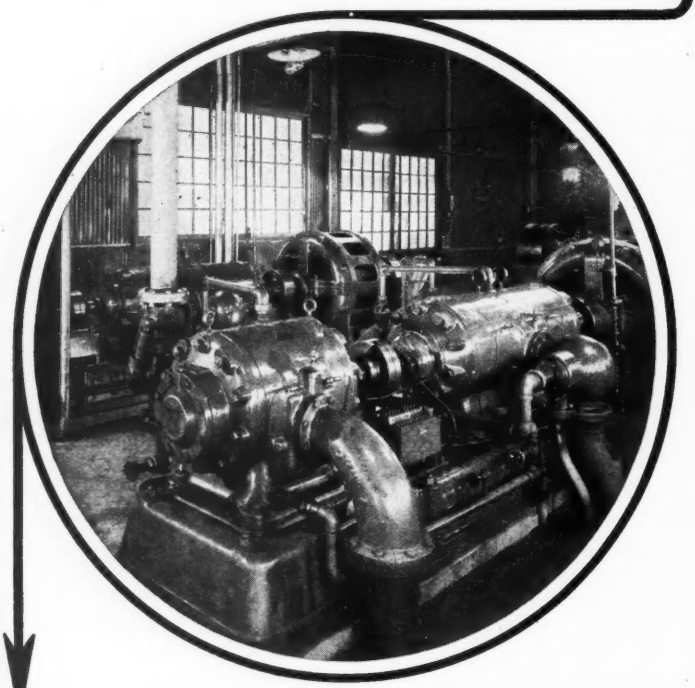
ENTERPRISE ENGINE & FOUNDRY CO.

18th & Florida Streets, San Francisco 10, California

Offices in Principal Cities

HERE'S WHAT YOU GET WITH A

Fuller Rotary Compressor



DIRECT DRIVE . . . ACCESSIBILITY . . . LOW MAINTENANCE . . . SIMPLE FOUNDATIONS . . . BLADES AUTOMATICALLY COMPENSATE FOR WEAR . . . SMALL FLOOR SPACE WITH RELATION TO CAPACITY . . . MAINTAINED CAPACITY FOR THE LIFE OF THE MACHINE . . . UNNECESSARY BULK ELIMINATED . . . NO BEARING TAKE-UP . . . NO LEAKING VALVES OR SEATS TO GRIND . . . NO AIR-LINE PULSATIONS . . . NO MULTIPLICITY OF PARTS REQUIRING FREQUENT ATTENTION, ADJUSTMENT AND REPLACEMENT.

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mended for all couplings, that heavy strap iron guards be made for each end of the floating shaft to confine the rotation of the shaft should the couplings fail. This is done to prevent the loose end of the shaft from whipping around and damaging the fan, as well as the motor and gear shafts.

The universal joint type coupling requires lubrication every three to four weeks. This type of coupling requires a heavy oil rather than a grease. Properly lubricated, this type of coupling will give by far the best service of any of the couplings previously mentioned since its greater flexibility better adapts it for use on a wooden structure which is not rigid.

The gear and motor should be checked for proper alignment once a year. The following procedure for aligning floating shaft couplings is recommended:

The floating shaft and couplings should be removed, leaving a flanged hub on both the motor and gear shaft. Stretch a fine copper wire or chalk line over the top of both the motor and gear flange. Next, check with a square against the flange face and wire, first on one coupling and then the other. The square will show any misalignment. This should be done both with the wire or chalk line on top of the coupling and on the side of the coupling. Shifting of the motor and gear and shimming will make one edge of the square parallel with the wire in both positions. When this is accomplished, the unit will be in proper alignment.

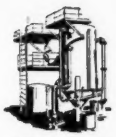
Fan Maintenance

Fan blades used on cooling towers are: (1) fabricated carbon or stainless steel, (2) cast aluminum, or (3) airplane wing section type.

Once a year the fan blade arms should be examined for fatigue cracks; this applies to all classes of fans. The fabricated stainless steel fan should require little or no maintenance while the carbon steel and aluminum fan blades may be scraped and coated each year or two with a preserving material. On the other hand, carbon steel and aluminum fans have been known to give five to ten years of service with no maintenance work on the blades whatsoever.

The airplane type of fan blade consists of struts covered with fabric or metal. This type should be examined every three to six months for tears or rips in the covering. Should this occur, repairs should be immediately made lest the entire fan be destroyed.

A fan will become sufficiently unbalanced in normal service to require rebalancing every 3 to 5 years. This occurs because of the uneven erosion, corrosion, or deposition on the blades over a period of years. Very often, vibration on top of a cooling tower will be blamed on the fan when, in reality, it is due to



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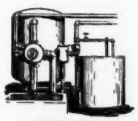
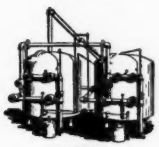


ZEOLITE SOFTENERS



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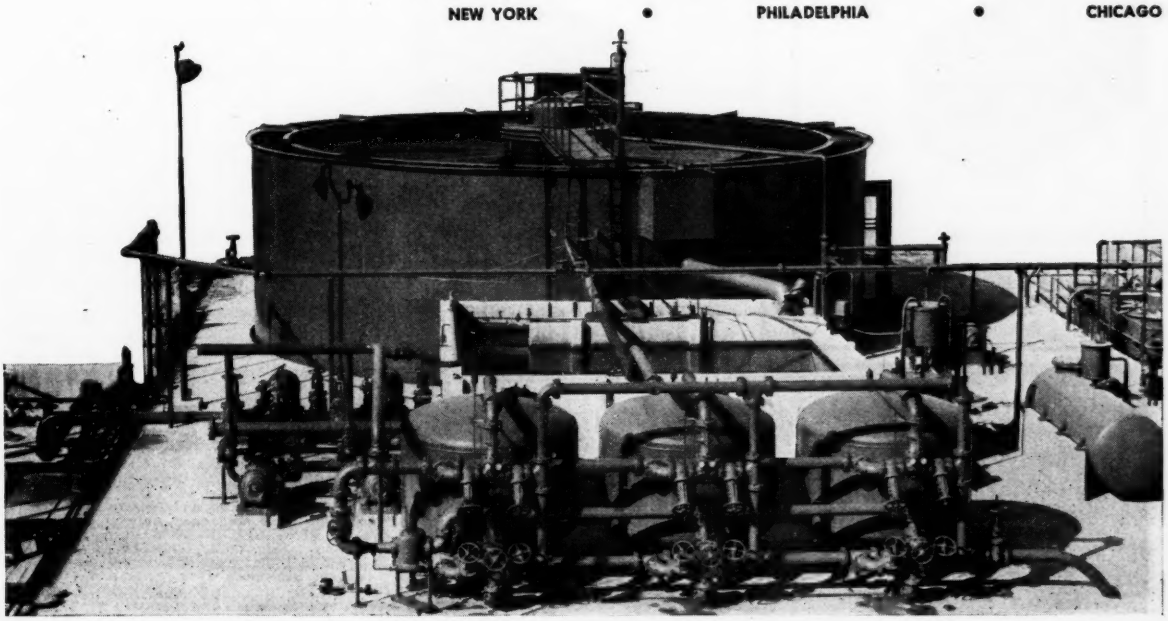

misalignment of the gear and motor.

These two vibration sources can be readily distinguished. The vibration caused by an unbalanced fan will give a swaying motion to the tower because of its relatively great mass and slow speed, while the misalignment of the motors and gears will cause a high-speed vibration which makes a rapping sound.

STATEMENT OF OWNERSHIP

STATEMENT of the ownership, management, circulation, etc., required by the act of Congress of August 24, 1912, as amended by the acts of March 3, 1933, and July 2, 1946, of POWER GENERATION, published monthly at Chicago, Illinois, for October 1, 1948. .

State of Illinois, } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Kingsley L. Rice, who, having been duly sworn according to law, deposes and says that he is the Business Manager of the POWER GENERATION and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily, weekly, semiweekly or triweekly newspaper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the act of August 24, 1912, as amended by the acts of March 3, 1933, and July 2, 1946 (section 537, Postal Laws and Regulations). printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and other business managers are:

Publisher, Technical Publishing Company, Chicago, Illinois.

Editor, Andrew W. Kramer, Chicago, Illinois.

Managing Editor, Chester R. Earle, Chicago, Illinois.

Business Manager, Kingsley L. Rice, Chicago, Illinois.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

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4. That the two paragraphs next above, giving the names of the owners, stockholders, and securi'y holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustees or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is ..... (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

KINGSLEY L. RICE, Business Manager
(Signature of business manager)

Sworn to and subscribed before me this 30th day of September, 1948.

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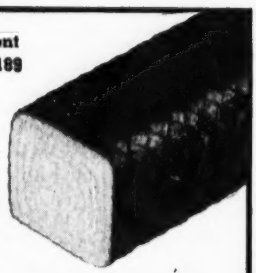

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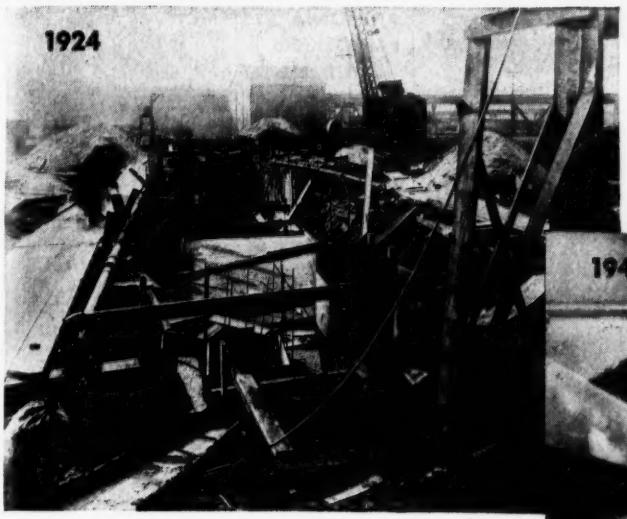

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AMMONIA SYSTEM EXPLOSIONS

(Continued from page 73)

7. VAPOR ONLY.

Vapor only is not likely to cause an explosion, except in most unusual circumstances.

8. VAPOR AND LIQUID.

Although the vapor pressure in an isolated part of the system may be low, it can be raised to a critical point within seconds, if there is a small residue of liquid, and heat is applied. For this reason residues of liquid in a system should be guarded against. If heat must be applied near a liquid pocket, it should be done before the last isolating stop valve is closed. If steam, hot water, or flame is used to clean, defrost, or weld, heat transfer is rapid. These substances should never be applied to any part of an ammonia refrigeration system, except with great caution.

9. VAPOR AND OIL.

A vapor-oil mixture is never dangerous, except when flame is applied to the system.

10. VAPOR, OIL AND LIQUID.

Because a small quantity of liquid makes several hundreds of times its volume of vapor, its presence in an oil-vapor mixture adds danger to an isolated part of the system.

11. OIL ONLY.

Oil only is not dangerous, except in the presence of flame.

12. OIL AND LIQUID.

Since neither of these substances is elastic, they may rupture any containing vessel if no vapor pocket is left for a cushion.

13. LIQUID ONLY.

It is highly dangerous to isolate liquid ammonia without leaving a vapor pocket. If the liquid has been previously subcooled, the danger is greatly increased.

To examine a specific instance and check on the above given causes, let us take for example the ammonia system explosion in the Union Dairy Company plant at Decatur, Illinois, on May 4, 1948. This was a low side explosion, and took place in a direct expansion new milk cooler of 12,000 lb capacity per run. The terrific force with which the explosion ripped this vessel apart is shown in the illustrations. Rupture took place inward, and from the bottom upward. A workman cleaning the vessel with hot water was blown upward, and pinned against the top by the ragged tear of 12 ga. stainless steel. Another workman was critically injured, and three more hospitalized.

Expansion was by low side float. Like any other expansion valve, this effectively sealed the evaporator outlet into the liquid line, except in cases of very gradual pressure rise. Other than the acknowledged use of hot water for cleaning, there

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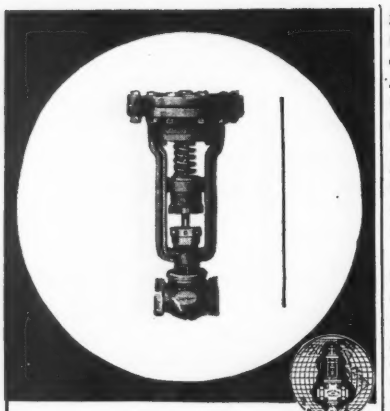

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is some difference of opinion about the causes of the explosion. However, the outlet may have been restricted by closing, or partly closing, the return valve, stopping of the compressor, or by some other obstruction. If the evaporator were filled with liquid, high resistance to turbulent flow may have sealed the return line to escape of liquid long enough for rupture to take place.

Study of the pictures shows that the causes of the explosion fall under system conditions (A) 1, 2, 5, and 6, with charge condition 8, or possibly 13. Charge condition is shown by the fact that rupture force came from the bottom of the vessel, where liquid ammonia would necessarily lie.

Study of system conditions show that the walls of the evaporator space could not possibly withstand nigh pressure. The ratio of wall thickness to vessel diameter is enormously great, so great, in fact, that D in the formula $(2tSe) \div D = p$ practically extends to infinity. There was little strength of wall material to prevent rupture, even at normal operating pressure of 65 psig. This is especially true of the inner wall, and away from the reinforcement of the heads, where rupture actually took place.

Therefore the holding strength of the vessel against ammonia pressure fell upon the stays. These were welded and riveted, as shown. While the stays in themselves were strong enough, any practical engineer can see that they were much too widely spaced for the thickness of wall material. Should one stay fail, the thin metal wall would be certain to fail, due to the great unstayed area left and the prying force exerted upon the adjoining stays by the buckling metal.

The safety valve on this vessel was set to blow at 90 psig. Without question, this was too high for this particular vessel. Therefore the system was faultily installed. Welds were also faulty. And the use of a flooded evaporator in a vessel that had to be cleaned with warm water points up a dangerous system layout.

NOTE: The photographs illustrating this article were supplied by F. C. Bair, Plant Superintendent, Union Dairy Co., Decatur, Ill.

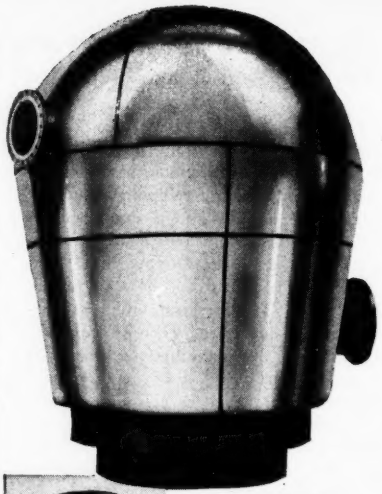
ATOMICS

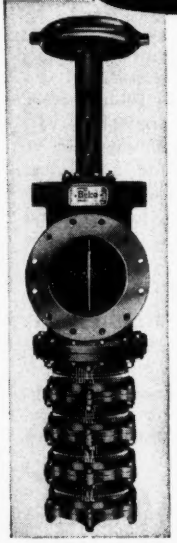
ARE WE HERE TO STAY?

(Continued from page 81)

entire plant before the reactor is actually put into operation.

In recognition of the fact that atomic power plants must be so constructed as eventually to permit their operation in populous areas, a





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PROCESSES FOR REMOVAL OF WATER IMPURITIES

first requirement of design is to assure complete and adequate control at all times. Studies of control mechanisms and safety measures have been under way at the Knolls Atomic Power Laboratory for two years. A major objective of the design work has been to make sabotage so difficult as effectively to remove sabotage as a threat to continued operation of the reactor.

The design, construction and operation of this first atomic power plant will be watched with great interest by all those interested in atomic power development. It is to be hoped that the military will not be able to impose such air tight security regulations around the operation of this plant as to keep information of value from the power engineers of this country. If we are ever to have atomic power plants it is high time that we get started. It is now six years since the first nuclear reactor went into operation on December 2, 1942, at the University of Chicago and since that time very little has been done to develop a practicable power plant using nuclear energy as the source of power.

Perhaps if we can show the world that atomic power is available in practically unlimited quantities, the need for atomic bombs will vanish. Power is one of the strategic commodities over which nations will go to war if they don't have it. If all nations could be assured of an unlimited supply of power, at least that particular cause for war would be eliminated. Like the Shmoo, it would make everybody happy.

HIGH VOLTAGE D-C TRANSMISSION STUDIES IN GERMANY

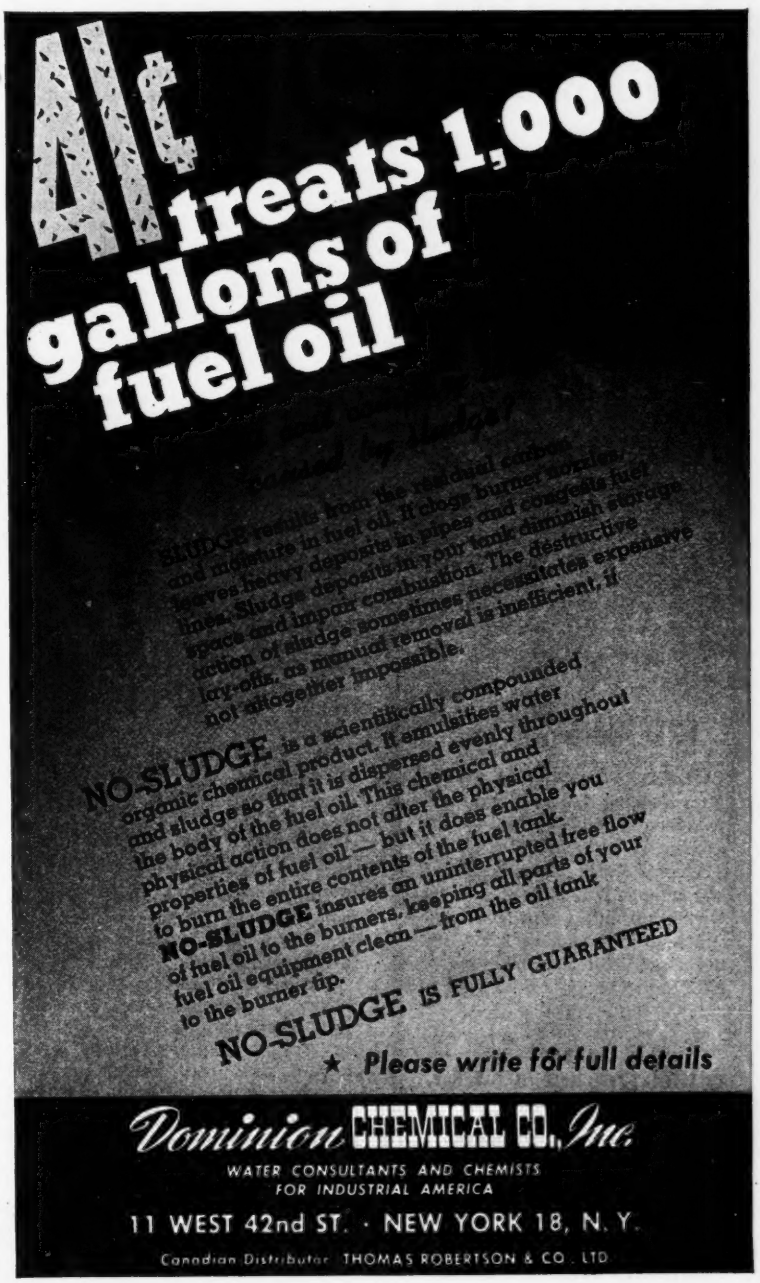
DEVELOPMENT of high voltage direct current transmission was favored by German aviation authorities before the war since this type of electrical distribution made possible substitution of underground cables for overhead lines carrying a-c current, according to a report now available to the public, the Office of Technical Services. Department of Commerce, announced recently.

The report is a comprehensive review of the theory and practice of German high-voltage long-distance transmission and includes an account of experiments undertaken in replacing a-c with d-c current on proposed 400 kv lines.

The original German text by Dr. Ing. F. Busemann, of Siemens-Schuckert A.G., Berlin, has been translated by Alexander Dovjikov, U. S. Department of the Interior, Bonneville Power Administration. The translator states in his introductory notes: "We believe that Dr. Busemann's report is of such fundamental and general interest that it should be brought to the attention of American engineers, even if we may not fully agree with some of his statements."

The German State Secretariat for Aviation held that overhead lines not only impeded construction of airports, but also facilitated the location of important targets. Hence this organization had a major interest in the development of high-voltage direct current transmission (HVDCT). The German utility companies were also interested in HVDCT because its adaptability to underground cable construction indicated a way of lessening atmospheric disturbances to which overhead lines are vulnerable during storms, sleet, and other adverse weather conditions. In addition, the utility companies were considering the use of HVDCT for increasing the capacity of existing overhead lines operating on a-c because it could carry the same current load with a smaller conductor.

The report concludes that development work had proceeded far enough in Germany to put three-phase 400 kv systems into immediate construction, but that d-c lines of the same capacity still have design problems to be overcome. Specifically, satisfactory mutators for continuous operation and adequate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short-circuit breakers were still problems to be solved.

"If the long distance transmission for pressing reasons has to be made by underground cable, the d-c transmission has advantage in every case," the report states. It points out that for overhead lines, economies must be carefully studied in each particular case.

WINSTON RESIGNS AS DIRECTOR OF MIDWEST POWER CONFERENCE

STANTON E. WINSTON, dean of the evening division and professor of mechanical engineering at Illinois Institute of Technology, Chicago, has resigned as director of the annual Midwest Power Conference.

Roland A. Budenholzer, professor of mechanical engineering at Illinois Tech, has been named to replace Dean Winston, who has served as conference director since 1940.

Dean Winston was instrumental in the reorganization and reactivation of the Midwest Power Conference in 1939 and served as its secretary in 1938 and 1939 before assuming the directorship. The growth of Illinois Tech's evening division has prompted him to relinquish his position and devote full time to his administrative duties with the Institute.

Dr. Budenholzer attended high school in Belen, New Mexico, received a bachelor of science in mechanical engineering at New Mexico State College in 1935, and a master's degree and doctorate at California Institute of Technology in 1937 and 1939, respectively.

E. R. Whitehead, director of the department of electrical engineering at Illinois Tech, will continue as conference secretary and W. A. Lewis, dean of the graduate school, will serve again next spring as university representative for Illinois Tech.

The 1949 meeting will be held April 18, 19, and 20 at the Hotel Sherman in Chicago.

STEAM PIPES FOR HOTTEST TURBINE TO RUN DULL RED

THE 100,000-kw turbine recently shipped by the Westinghouse Electric Corp. for installation at the Sewaren Generating Station of the Public Service Electric and Gas Co. of New Jersey will operate at such high temperatures and pressures that the steam pipes feeding it will glow a dull red. Steam at 1500 pounds pressure and 1050 F will feed the new 3600-rpm tandem compound double flow machine. This is the first steam power plant to be constructed for operation under such conditions.

While the highest temperature previously used in turbines is 1000 F, it is the last 50 F that makes the job tougher. To withstand operating

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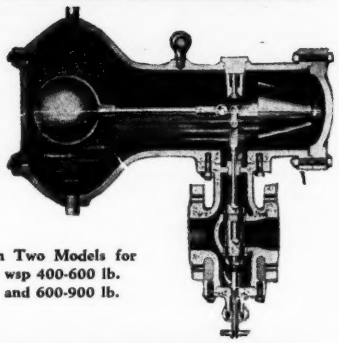

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Send for Bulletin 148 B.P.

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in the dull red region steam containers such as the throttle valves, steam chests and other high pressure parts of the turbine are constructed of 18-8 stainless steel. Fabrication of parts from this hard-to-work material has been a problem in itself.

The importance of the 50 deg rise in temperature is in the fuel savings. For each 50 deg increase, the quantity of coal required to produce one kilowatt hour of electrical energy is decreased by about 1.4 per cent. In 1915 the output of all our steam power plant turbines averaged only 525 kwhr per ton of coal burned. With further developments towards increased plant efficiency, the output of all steam power plants by 1945 was 1550 kwhr per ton of coal burned. These figures include both old and modern plant equipment in service during the year mentioned. This new turbine will produce about 2500 kwhr of electrical energy from each ton of coal burned.

WORLD'S LARGEST KVA TRANSFORMERS FOR DETROIT EDISON

THREE OF THE world's highest rated kva transformers ever made will be built by General Electric for The Detroit Edison Co., according to Robert Paxton, manager of G.E.'s Transformer and Allied Products Divisions.

The transformers, each of which are rated three-phase, 145,000 kva, are designed to raise voltage from 15,000 to 135,000 v.

Without being the world's largest kva output transformers in terms of size and weight, they are the largest in terms of electrical energy. This achievement is made possible by the use of a cold rolled, oriented silicon steel called "Corosil" for the magnetic cores and forced, directed flow of the cooling liquid. These features reduce the weight of the transformer to about 75 per cent of a comparable self-cooled transformer and save a considerable amount in cost.

Because of the reduction in size and weight, it will be possible to ship these large transformers in their own tanks, in an upright position. To install the transformers, they will be skidded off the car into place and only the cooling units and bushings will have to be mounted.

GRAND FORKS LIGNITE LABORATORY PLANS

WORK ON the design of the $750,000 lignite research laboratory to be constructed by the Bureau of Mines at Grand Forks, N. D., will start immediately and construction is expected to get under way this fall. Secretary of the Interior J. A. Krug has announced. Completion of the research center, authorized by the 80th Congress and approved by the President on June 29, is scheduled for the end of 1949.

The research center's basic facilities will include a laboratory for small-scale research, a general service section for supplies, and a machinery bay suitable for large-scale pilot plant research.

Because lignite is a high-moisture coal which tends to crumble upon exposure to air, its present use is restricted primarily to the Dakotas and adjacent areas. To help expand the geographic distribution of a fuel which represents nearly one-fifth of the Nation's coal reserves, the new research center will concentrate upon improved methods of drying lignite. Development of effective drying methods will permit the transportation of lignite to more distant areas and will reduce the demand for higher-rank fuels. Bureau research will also be directed toward developing equipment for burning lignitic fuels and more efficient coal-gasification methods.

Other phases of the research program to be conducted at the laboratory will include study of gasify-

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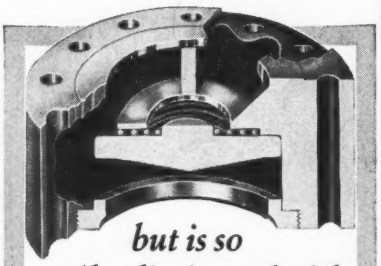

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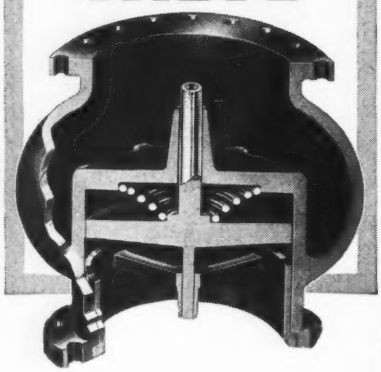

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ing lignite to provide high-hydrogen gas for reducing low-grade Minnesota ores and the development of new scientific, chemical and technical uses for lignite and its products.

American lignite reserves are estimated at approximately 939,000,000 tons. Of this total, 915,000,000 tons or about 98 per cent are in North Dakota, eastern Montana and South Dakota. Small reserves also exist in Texas, Alabama, Mississippi, Washington, Wyoming, California and Arkansas.

Dr. Samuel E. Sheppard, widely known for his research on the sensitivity of photographic materials, died September 29, in Rochester, New York. He had been in retirement since January, 1948, after 35 years with Kodak Research Laboratories.

Boddy-Benjamin Associates, Inc., architects and engineers, have announced the opening of offices at 2210 Park Avenue, Detroit. With architectural, structural, mechanical and electrical departments, the firm is prepared to render complete architectural and engineering services on industrial, commercial, and public buildings, and on industrial and public utility power plants.

Principals in the firm are: Fred A. Boddy, Max W. Benjamin, and Frederick H. Potz. All three are University of Michigan men, classes of 1924 and 1926, and all are members of the Engineering Society of Detroit. Mr. Potz is a registered architect, a member of the American Institute of Architects, and formerly Architect-in-Charge for Albert Kahn, Inc.

Messrs. Boddy and Benjamin are both registered mechanical engineers and active members of the ASME. Mr. Boddy has designed and supervised the construction of manufacturing plants and power houses for General Motors Corp., Merritt-Chapman & Scott Corp., and other concerns throughout the United States and Canada. Mr. Benjamin was with The Detroit Edison Co. for 19 years as a steam power engineer, specializing in heat balances, economic studies, equipment selection and related phases of power plant design.

Hand of welcome to Richard W. Porter, recently appointed editorial director of *The Paper Industry and Paper World* published by Fritz Publications, Inc., Chicago. Mr. Porter took over his new responsibilities September 1, succeeding Harry E. Weston, now with the Association of Pulp and Paper Mill Superintendents.

Since 1945, Mr. Porter has been on the editorial staff of *Chemical Engineering.* He holds a B.S. degree from the University of Washington, 1936. He was first connected with Crown Zellerbach Corp., Port Town-

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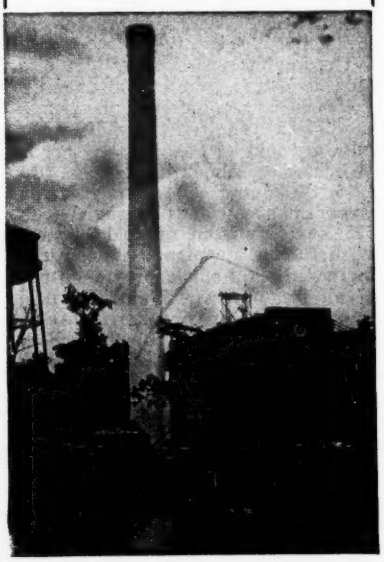

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send, Washington, in the technical control department. Four years later, he served at the company's mill at Carthage, New York, where successively, he held positions in the technical control, engineering, and purchasing departments. From 1942 to 1945 he was application engineer with The Brown Instrument Co., Philadelphia. He is a member of the American Chemical Society and the Technical Association of the Pulp and Paper Industry; and chairman of the TAPPI Mill Instrument Control Committee.

Julian E. Tobey, Director of the Fairmont Coal Bureau and William Amyx of the Bureau's staff, have resigned from the Bureau as of September 1 to join Appalachian Coals, Inc., at Cincinnati, Ohio. Earl C. Payne has been appointed Acting Director of the Fairmont Coal Bureau in New York City.

Elliott Co., Jeannette, Pa., has been awarded a contract of more than a million dollars for 40 generators, each of 1100 kw capacity, for use in the recently announced new aluminum-producing plant of the Aluminum Co. of America at Point Comfort, Texas. These generators are direct-current and are provided with slip rings for an alternating-current output of 150 kva. They will be driven by engines designed to operate on natural gas. The direct-current output of these Elliott generators will be used for the reduction of alumina to aluminum by electrolysis. The alternating-current output will be used to drive all the auxiliaries, such as oil pump, water pump, scavenger blower, etc., on the corresponding gas engine.

D. J. Erikson, who started his career with Hagan Corp. as a draftsman more than three decades ago, has been elected president of Hagan and its subsidiary companies—Calgon, Inc., Hall Laboratories, Inc., and Buromin Co. He succeeds J. M. Hopwood, president of Hagan Corp. since 1918—the only man to predate Mr. Erikson in point of service with the company. Mr. Hopwood was elected to the new position of chairman of the board of directors of the Hagan group.

SKOG ELECTED TO IIT TRUSTEES BOARD

Ludwig Skog, senior partner of Sargent & Lundy, Chicago firm of consulting engineers, has been elected to membership on the board of trustees of Illinois Institute of Technology.

Born in Bodo, Norway, Mr. Skog obtained his M. E. degree from the Trondheim Polytechnic Institute in Norway. In 1909 he became a draftsman for the Inland Steel Co. at Indiana Harbor, Ind. He joined Sargent & Lundy as draftsman in 1910 and has been associated with the firm since. He has been successively chief mechanical draftsman, mechanical engineer, chief mechanical engineer, director and chief mechanical engineer, vice president and chief engineer, partner and chief engineer, and for the past year senior partner.

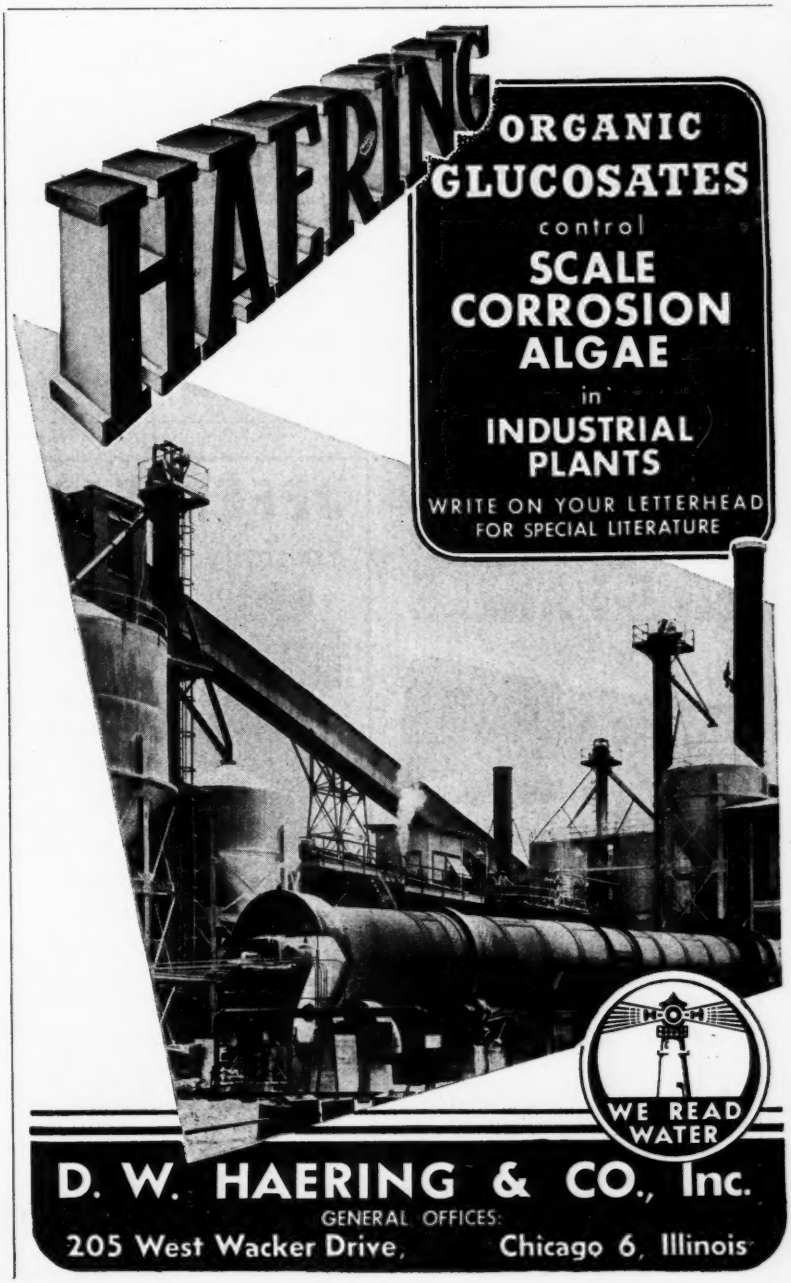
In 1938 he visited several European countries to study power plant engineering and returned to England to act as consultant to Merz & McClellan (London) on a large power plant in London.

From April 1943 to February 1946 he was loaned by his firm to Kellex Corp. as engineer in charge of design and construction for power development and mechanical process engineering for the Oak Ridge gaseous diffusion plant.

Mr. Skog is a member of ASME, ASTM, WSE, AWS, and the Union League Club.

NACA SELECTS BURNS AND ROE

The National Advisory Committee for Aeronautics has awarded to Burns and Roe, Inc. of New York a contract as consulting engineers in the design of a new Propulsion Sciences Laboratory. This new laboratory is to be constructed at the



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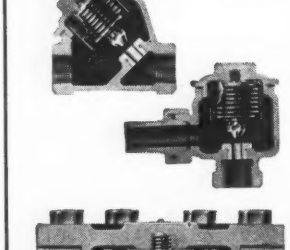

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NACA's Lewis Flight Propulsion Laboratory at Cleveland, Ohio. It will be the latest addition to the facilities now operated at Cleveland.

WESTINGHOUSE ANNOUNCES ATOMIC POWER DIVISION

GWILYM A. PRICE, President of the Westinghouse Electric Corp. has announced the formation of an Atomic Power Division which will concentrate solely on the harnessing of nuclear energy for the production of useful power.

According to Mr. Price, the new Division "will be available to undertake atomic energy projects for the United States Government as well as to carry on independent studies. It will conduct research, development, engineering, and any necessary associated construction." It will work closely with the Westinghouse Research Laboratories and with other divisions of the company so as to benefit from their knowledge, experience, and facilities. Location and other details of organization will be announced later.

Manager of the Atomic Power Division will be Charles H. Weaver.

New ENGINEERING BOOKS

Index to A-S-T-M Standards, December 1947, 248 pages, size 6 by 8½ inches, paper covered; published by the American Society for Testing Materials, 1916 Race Street, Philadelphia, 1948.

This Index is an adjunct to the Book of A.S.T.M. Standards and comprises a ready reference for locating any A.S.T.M. standard in the bound publication of the Society in which it appears. The Index should also be of value in ascertaining whether the Society has issued a standard on a specific subject. It enables any of some fifteen hundred standard specifications and tests in the volumes of the A.S.T.M. to be located readily. All items are listed in the index under appropriate key words according to the particular subject they cover. As a convenience a list is given of the specifications and tests in numeric sequence of their serial designation. Copies of this 248 page publication are furnished without charge on written request to A.S.T.M. Headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania.

• • •

Boiler Performance Simplified, 12 pages, 6 by 9 inches, paper cover; published by John D. Troup Ltd., 90 High Holborn, London, W.C.1, price two shillings sixpence.

This little book is a reprint from the Steam Engineer of London September, December 1946. It constitutes a short series of articles by Sydney D. Scorer dealing with the fundamentals of operational control. The chapter headings are as follows: Preparing for a Boiler Test, Cost of Steam per Therm, Checking and Graphing Boiler Performance against Standard Performance under clean conditions, Graphical Method of Calculating the approximate amount of air used for combustion, Comparison of Complete Analysis with Approximate Method of Calculating Boiler Performance.

• • •

Supercharging the Internal Combustion Engine by E. T. Vincent, First edition, 315 pages, size 6 by 9 inches, illustrated, cloth; published by the McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, 1948; price $5.00.

The purpose of this book is to present for the first time, the essential fundamental theory of the various forms of superchargers and turbo superchargers in use today, together with effects on the engine cycles, power outputs, and thermal efficiencies. The subject matter was built around some notes that were used in the

spring of 1944 for a course on superchargers sponsored by the U. S. Government under one of the war training programs. Interest in the course was so gratifying that the author thought the notes should be published in more permanent form.

Following an introductory chapter on the historical development of the superchargers, chapter 2 deals entirely with the fundamental thermodynamics. Chapter 3 is on the engine cycle, describing the constant volume cycle, supercharged constant-volume cycle, the turbosupercharger, etc. In chapter 4 is discussed the various types of compressors, this is continued in chapter 5. Chapter 6 is devoted to a discussion of the impeller and diffuser and chapter 7 to the estimating operating conditions. Surging in centrifugal superchargers is discussed in chapter 8 and chapter 9 is devoted to the testing of superchargers. Chapter 10 covers turbosupercharging in general, and chapter 11 the axial-flow compressor. The book concludes with a chapter on the supercharged diesel cycle.

The author is Professor of Mechanical Engineering at the University of Michigan.

• • •

Battlefronts of Industry by David O. Woodbury, First edition, 342 pages, 6 by 9 inches, illustrated, cloth; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, 1948; price $3.50.

While this book describes the activities of the Westinghouse Electric Corp. in World War II, it is, of course, a general account of the technical developments which made World War II so different from any other war that has ever been fought. It is the battle narrative of all American industry.

David O. Woodbury, the author, is well known in both literary and scientific circles. He is an outstanding writer and engineer and radio and movie producer. In this book Mr. Woodbury tells how Westinghouse designed and produced everything from electric torpedoes, tank-gun stabilizers, optical instruments, bomb fuses to the precipitron and jet propulsion units. This book shows the typical reaction when inherent mechanical genius is pushed into the open by a threatening enemy. Day and night men worked to find new principles, new applications of old ones. Forgetting the passage of time, abandoning sleep, comfort, and even health, they got these new things into mass production and followed them to the many fronts in order to improve them constantly. The book will be an inspiration to everyone associated with American industry.

• • •

Proceedings of the Annual Meeting, Smoke Prevention Association of America, Inc., 1947. 120 p.; illustrated; size 8½ by 11; paper bound. Published by John Paul Taylor, Publisher. Price $2.50.

This large volume contains all the technical as well as the general paper presented at the 1947 annual meeting. It contains up-to-date and authoritative information on practical methods of preventing smoke. Each paper was written by an authority in the field. Book also contains the discussion on each paper which came from the audience.

General smoke prevention practices and how they may be applied to industry, railroads, and city smoke prevention groups are discussed thoroughly by men actually engaged in and responsible for smoke prevention.

Illustrations are mostly drawings from which it is possible to apply this information to a particular case.

• • •

Wear and Lubrication of Piston Rings and Cylinders, by Dr. Reemt Poppinga, translated from the German by Dr. Edmund Kurz; 200 pages; size 5½ by 8½ in.; cloth bound; Published by The American Society of Lubrication Engineers, 343 S. Dearborn St., Chicago. Price $2.50.

This book presupposes a certain amount of basic information concerning the causes of wear simply because, despite tremendous amounts of research on the subject, all causes of wear have yet to be determined. Numerous data upon which this book is based were made available to the researchers by the Reich Ministry of Transport and other German organizations.

Investigation was made, and is reported in the book, on the influence of the lubricant upon wear and also on the influence of engine operating conditions upon both lubrication and the wear of cylinders and piston rings. Another section of the book reports on the influence of material structure on wear.

Steam, Air and Gas Power by William H. Severns and Howard E. Degler, Fourth edition, 509 pages, 6 by 9 inches, illustrated, cloth; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York; 1948; price $4.75.

The first edition of this book appeared in 1929. The purpose of this fourth edition remains the same as that of the first, that is to provide an elementary text book for courses dealing with heat engineering where time limitations preclude an exhausted coverage of all phases of the subject. The fundamental theory of heat power engineering are the same as those given in the three previous editions of this book. According to the authors, the primary objectives of this revision are to bring the material together with the illustrations and descriptions abreast of the present day developments of fundamental heat power equipment, to make the material more easily understandable by rearrangement of the subject matter, and to introduce distinctive new material which appears to be of immediate and growing importance. The volume constitutes a useful link between the more rigorous theory and the actual practice of power production.

Steam, Air and Gas Power is a descriptive book, with sufficient technical detail and mathematical calculation to provide a thorough understanding of basic principles. Clear discussions and illustrations show the underlying theory of the construction, applications and performance of modern heat-power plants and their correlated equipment. Carefully chosen problems, most of which are entirely new in this fourth edition, give the reader practice in applying the principles as he learns them. The addition of material on the gas turbine is one of the most important changes in this fourth edition.

The authors are both men of wide experience in the field of power engineering and both either are, or have been, professors of mechanical engineering in lead-

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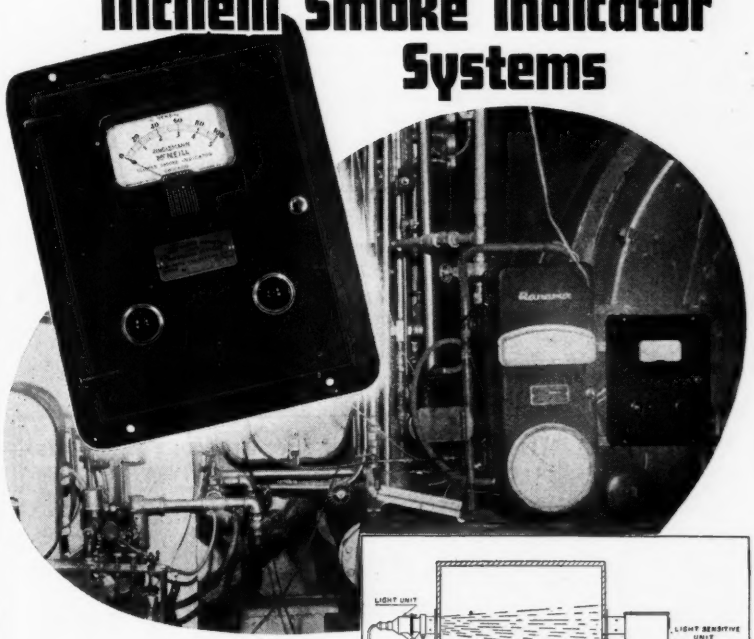

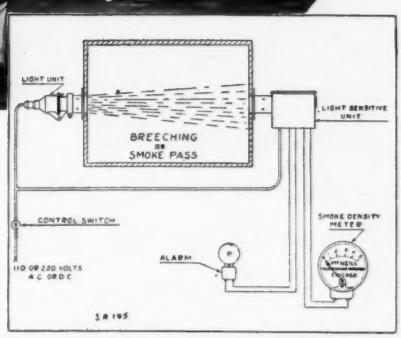

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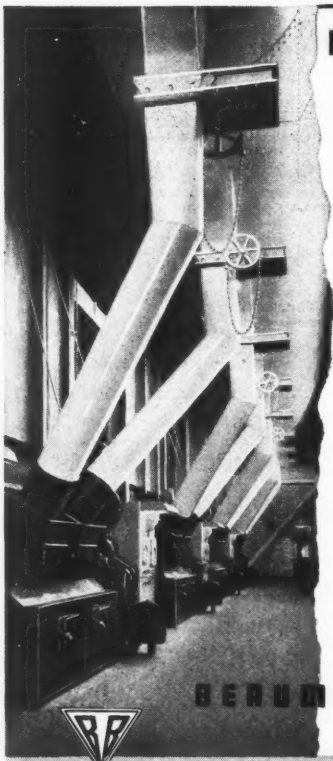

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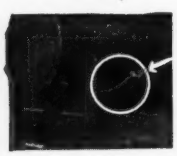

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ing colleges. At the present time Mr. Severns is Professor of Mechanical Engineering at the University of Illinois. Howard E. Degler is Technical Director of the Marley Company at Kansas City and was formerly Professor of Mechanical Engineering at the University of Texas.

● ● ●

Trends in Engineering Education by James Kip Finch, First edition, 140 pages, 5½ by 7¾ inches, cloth; published by The Columbia University Press, New York, 1948; price $2.00.

Practicing engineers as well as educators will be interested in this very enlightening little book on engineering education. As in many other branches of human endeavor, change is the normal atmosphere in engineering education. Today in particular engineering education faces a transition and a challenge to greater service. Two problems especially pose questions of policy with which many schools have had little experience. The purpose of this book, therefore, is to present these solutions as they have been evolved through the pioneering work of the Columbia School of Engineering.

One problem has been the move to broaden engineering curricula to include the basic subjects of a general education. The other, and even more important, is the challenge our schools face today in advancing both the fundamentals and the applications of engineering science. While American engineers have led the world in technical ingenuity, in the area of basic research they have relied to a major degree on European workers. American engineering schools must now meet this loss of basic research by increasing their own interest in graduate study.

According to Dean Finch American engineering schools are turning out tens of thousands of young men a vear, who are educated either beyond their capacity or below the top needs of the profession.

The book records the experience of twenty-five years of general education at Columbia College. It describes how such a program has been carried out and how it has developed and changed. It shows such a program in action under actual prevailing conditions in higher education. Although the book was undertaken primarily for the further advancement of its own work, it is an invitation to educators every where to share freely in the Columbia Experience.

● ● ●

Industrial Electronics Reference Book by Electronics Engineers of the Westinghouse Electric Corporation, First edition, 680 pages, 9 by 12 inches, illustrated; cloth; published by John Wiley & Sons, Inc. 440-4th Avenue, New York; 1948; price $7.50.

At $7.50, or if it cost twice as much, this by all odds constitutes the greatest amount of electronic information that one could buy in a single book. It is without doubt the most comprehensive and at the same time the most practically useful book on electronics that has been written so far. Whether you are an experienced electronics engineer of many years standing, or merely a beginner, this book is well worth having.

As pointed out in the preface, since 1940 wide spread expansion has taken place in the field of electronic engineering. Marked advancement was made in the industrial phases of electronics with the results that this branch of engineering was directly related to the momentous production record of industry during this period. Developments took place so rapidly, that it was almost impossible for one not highly skilled in such equipment to keep pace. The need for a digest embracing the application as well as design data for industrial electronic equipment under one cover was evident. This book, the Industrial Electronics Reference Book, was written to satisfy this need. It has been prepared with the hope that the technical data and application information set forth between its covers will enable those concerned with the application and utilization of electronic apparatus to have a better understanding of the possibilities and limitations of such equipment. The book has been aimed at the practicing engineer, who is faced with the problem of understanding the underlying principles as well as the scope and limiting factors of electronic apparatus as it is applied to industrial processes. While it is primarily designed for the practicing engineer, the book should also be of great value to graduates of engineering schools who are entering industry, and who will be faced

with the problem of applying electronic equipment or at least of approving or rejecting such equipment in industrial plants.

The great value of this book, is probably due to the fact that it has been written by a group of engineers, each thoroughly versed in his particular branch of the subject. These particular authors were chosen because of their broad experience, deep interest, and close association over a period of years with that phase of the industrial electronics field about which they have written. The authors have been intimately concerned with the rapidly expanding electronics field during the past decade, and they have imparted many valuable and lasting contributions to this branch of electrical engineering.

While it is impossible in a brief review to describe the subject matter of the various chapters in detail, a brief description of the book as a whole may be of interest.

Chapters 1 through 3 cover the basic laws governing the production and control of electrons, the kinetic theory of gases atomic structure, and the electron theory of solids.

Chapters 4 through 10 embrace the design, operation, and constructional features of different types of electron tubes—vacuum tubes, gas filled tubes, x-ray tubes, cathode ray tubes, photoelectric devices and ultar-violet radiators.

Electronic circuit components including resistance forms, capacitance, inductance, and tuned circuits are presented in chapters 11 through 18, while the design and application factors relating to transmission lines and antennas are covered in chapters 19 and 20. The many different parts of industrial equipment, including power line carrier equipment, power rectifiers and inverters, radio frequency heating and electronic instruments are presented with their advantages and limitations for industrial use in chapters 21 through 34.

The final chapters outline the factors involved in the care and maintenance of electron tubes and apparatus. Hundreds of illustrations help to elucidate every phase of the text material, the extensive list of references at the end of each chapter will aid the reader to locate additional material on any of the specific subjects involved.

Last but not least, the book has a very comprehensive index which makes it simple to find material on almost any subject included in the electronic field.

• • •

Heating, Ventilating and Air Conditioning Guide, 1948, 1280 pages, 6 by 9 inches, illustrated, cloth; published by the American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York, 1948, price $7.50 per copy.

This twenty-sixth volume of the Heating and Ventilating Guide like its immediate predecessor is composed of several sections. It contains first a technical data section of reference material on the design and specification of heating, ventilating, and air conditioning systems based on the transactions of the American Society of Heating and Ventilating Engineers, the investigations of the ASH & VE research laboratory and co-operating institutions, and the practice of the members and friends of these societies. The volume also includes a manufacturers' catalog data section containing essential and reliable information concerning modern equipment, the roll of membership of the society, and complete index to technical and catalog data sections.

The technical data section is divided up into eight major divisions. Section 1 is devoted to fundamental principles, that is to terminology, abbreviations and symbols, thermodynamic theory, fundamentals of heat transfer, performance of heating and cooling coils, natural ventilation, instruments and measurements and so on. Section 2 is devoted to the subject of human reaction to atmospheric environment. Heating and cooling loads are discussed in section 3. Section 4 is devoted to the general subject of combustion and consumption of fuels. Section 5 concerns heating systems and equipment, it contains descriptions of all the various types of heating systems in common use today. Section 6 is devoted to the general consideration of air conditioning, to dehumidification, refrigeration, air distribution, sound control and owning and operating costs. Section 7 is devoted to special applications, that is, to the industrial air conditioning, drying systems, transportation air conditioning, marine heating, ventilating, air conditioning, and corrosion and water formed deposits causes and prevention. Section 8 is devoted to the installation and testing codes.

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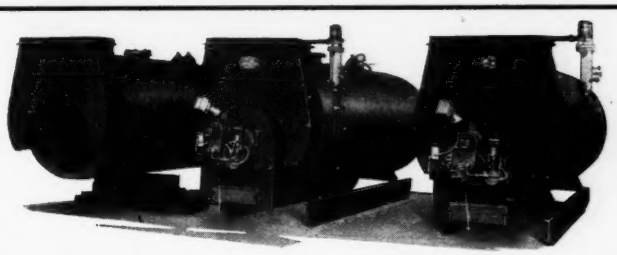

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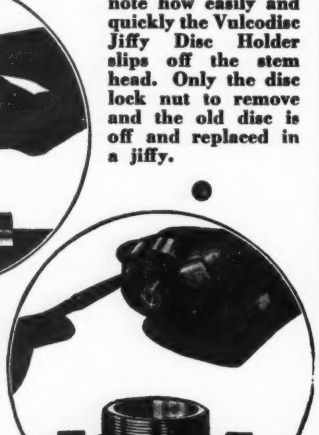

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POWER PLANT *Construction News*

Moss Landing, Calif.—Pacific Gas & Electric Co., 245 Market St., San Francisco, Calif., has authorized plans for a new steam-electric generating station at Moss Landing (Monterey County), with installation to include three 100,000 kw turbine-generators, high-pressure boilers and auxiliary equipment. Cost reported close to $50,000,000, including transmission lines, switching stations and other operating facilities. Stone & Webster Engineering Corp., Russ Bldg., San Francisco, and 49 Federal St., Boston, Mass., is engineer and will supervise construction.

Jacksonville, Fla.—City Council has plans in progress for new municipal power plant on Southside waterfront, where site has been selected. Land clearing will begin soon. No estimate of cost announced, but will represent large investment. Installation will include turbine-generators and accessories, high-pressure boilers and auxiliary equipment. Reynolds, Smith & Hills, 10 S. Laura St., Jacksonville, are architects.

Cicero, Ill.—Catholic Bishop of Chicago, 710 N. Wabash Ave., Chicago Ill., will build a boiler house for central-heating service in conjunction with a new two- and three-story school at Cicero, with boiler rating of about 3150-hp. Proposed to begin erection this fall. Joseph W. Bagnuolo & Associates, 221 N. LaSalle St., Chicago, are architects.

East Chicago, Ind.—Sinclair Refining Co., 3500 Indianapolis Blvd., refined petroleum products, plans new boiler house at local oil refinery, reported to cost close to $150,000, with boilers, pumps and auxiliary equipment. Main offices are at 630 Fifth Ave., New York, N. Y.

Michigan City, Ind.—Northern Indiana Public Service Co. has plans maturing for expansion in local steam-electric generating station, with installation of turbine-generator and other equipment for increased capacity. Proposed to begin work on superstructure at early date. No official estimate of cost announced. Sargent & Lundy, Inc., 140 S. Dearborn St., Chicago, Ill., is consulting engineer.

Kansas City, Kan.—Farm Belt Fertilizing Co., Kansas City, recently organized, care of S. J. Callahan, Finance Bldg., Kansas City, Mo., consulting engineer, plans boiler house at proposed new commercial fertilizer plant on local site at 23rd St and State Line. It will be one-story, 105x300 ft, reported to cost over $175,000, with machinery. Erection will begin soon. Engineer noted in charge.

Baton Rouge, La.—Gulf States Utilities Co., Louisiana Div., Baton Rouge, has had plans prepared by Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., consulting engineer, for proposed addition to local steam-electric generating station, recently referred to in these columns. Work on foundations will proceed at once. Cost reported about $15,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment. Engineer noted will supervise construction.

Jena, La.—Town Council plans new municipal power plant. Proposed to use Diesel engine-generator units and accessories. Cost about $150,000. A bond issue in that amount is being arranged. Local service is now being furnished by Gulf Public Service Co.

Madawaska, Me.—Fraser Paper, Ltd., bond, ledger and other papers, has plans for new power plant at mill. No estimate of cost announced but reported in excess of $250,000, with equipment. Contract has been awarded for structural steel framing and work will begin soon. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Marquette, Mich.—Dept. of Light and Power, Washington St., has plans under way for new municipal power station, with installation to include Diesel engine-generator units and accessories. No estimate of cost announced. Holland, Ackerman & Holland, 20 N. Wacker Dr., Chicago, Ill., are engineers.

Minneapolis, Minn.—Bd. of Public Welfare, City Hall, plans new steam power plant for central-heating service for buildings in Civic Center, including City Hall and general hospital. Cost estimated close to $1,500,000, with high-pressure boilers, pumps and other equipment. Ralph D. Thomas & Associates, Metropolitan Life Bldg., Minneapolis, are consulting engineers.

Ortonville, Minn.—Otter Tail Power Co., Fergus Falls, Minn., has plans for new 15,000-kw steam-electric generating station at Ortonville, reported to cost about $3,000,000, with

transmission lines, switching station and other operating facilities. J. F. Pritchard & Co., 908 Grand St., Kansas City, Mo., are engineers and will be in charge of construction.

Meridian, Miss.—General Box Co., 500 N. Dearborn St., Chicago, Ill., corrugated fibre, wood and other containers, plans boiler house at proposed new branch plant at Key Field, Meridian, where 20-acre tract of land has been acquired. It will comprise several buildings. Cost reported over $500,000, with machinery. McNair & Archer, Rosenbaum Bldg., Meridian, are architects.

St. Louis, Mo.—Falstaff Brewing Corp., 3684 Forest Park Blvd., has approved plans for new power house at 2000 Madison St., for service at former Columbia brewery, to be operated in future. Cost reported close to $100,000, with equipment. O. W. Steigemeyer, 452 Price Rd., Ladue, St. Louis, is architect.

Helena, Mont.—Bureau of Reclamation, Denver Federal Center, Denver, Colo., has plans in progress for new Canyon Ferry power dam and hydroelectric generating station, on site about 15 mi. from Helena. No estimate of cost announced. Bids are expected to be asked in near future.

Falls City, Neb.—City Light & Water Dept., 18th and Harlan Sts., is considering extensions and improvements in municipal steam-electric power plant, with installation of equipment for increased capacity. Estimates of cost are being made. G. G. Wendt is superintendent at station.

Franklin, N. C.—Nantahala Power & Light Co., Franklin, plans expansion and improvements in hydroelectric generating stations and ssytem, including installation of new hydraulic turbines, electric generators and auxiliary equipment. Cost estimated about $6,650,000. State Dept. of Public Utilities has approved project and expenditure in amount noted.

Raleigh, N. C.—Carolina Power & Light Co., Raleigh, is arranging bond issue of approximately $15,000,000, fund to be used for expansion and improvements in generating plants, power substations, transmision and distribution lines, and other operating facilities.

Winston-Salem, N. C.—R. J. Reynolds Tobacco Co., Patterson Ave., has plans for new addition to power plant at local cigarette and tobacco factory, with installation of a new 12,500-kw turbine-generator, boiler and auxiliary equipment. A new cooling tower will be built. Work is scheduled to begin soon. J. E. Sirrine & Co., Greenville, S. C., are consulting engineers.

Muskogee, Okla.—Consumers Cooperative Association, 320 E. 10th St., Kansas City, Mo., plans boiler house at proposed new commercial fertilizer plant at Muskogee, where site has been acquired. It will comprise several buildings for processing and general production. Cost reported about $200,000. Proposed to begin work soon. Howard A. Cowden is president.

Portland, Ore.—Pacific Power & Light Co., Public Service Bldg., Portland, plans new power substation in Willbridge district, estimated to cost about $420,000, with transformers, switchgear and auxiliary equipment. It will be used for service in North Portland and St. Johns areas.

Marcus Hook, Pa.—American Viscose Corp., Delaware Trust Bldg., Wilmington, Del., has plans for new addition to boiler house at rayon mill at Marcus Hook, with installation of boilers and auxiliary equipment for increased capacity. No estimate of cost announced. Work on steel framing will be placed under way soon.

Williamston, S. C.—Duke Power Co., 422 S. Church St., Charlotte, N. C., has selected a site on Saluda River, near Williamston, for proposed new steam-electric generating plant, for which plans will be prepared in near future. No estimate of cost announced.

Houston, Texas—St. Joe Paper Co., Barnett National Bank Bldg., Jacksonville, Fla., kraft corrugating and liner board products, plans power house at new converting plant on Post Oak Hy., Houston, where tract of about 38 acres of land has been secured. Main building, for corrugated paper box manufacture, will total about 100,000 sq ft floor space. Entire project will cost approximately $1,500,000. Austin Co., 16112 Euclid Ave., Cleveland, Ohio, is engineer, and will be in charge of erection. Work will be placed under way soon.

San Antonio, Texas—Public Service Board, 201 N. St. Mary's St., has plans under way for second unit of new steam-electric generating station on Leon Creek, to include new turbine-generator, high-pressure boiler and accessory equipment. Cost reported about $4,000,000. Work on first unit is now in progress, to cost approximately $3,000,000, with equipment, transmission lines, power substation and other operating facilities.

Alma, Wis.—Dairyland Power Cooperative, La Crosse, Wis., has plans for new addition to steam-electric generating station at Alma, with installation of new turbine-generator, to be known as Unit No. 3, and auxiliary equipment. No estimate of cost announced. Work will begin soon. Vern E. Alden Co., 120 S. LaSalle St., Chicago, Ill., is consulting engineer.

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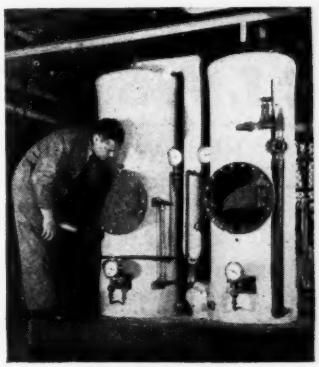

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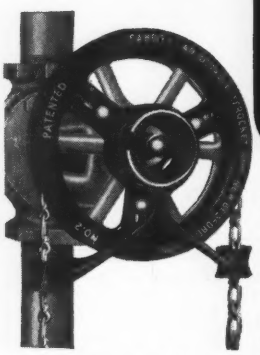

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YOU CAN MAKE THESE YOUR *Success Stories!*

Payroll Plan for U. S. Savings Bonds actually increases worker production, as demonstrated in large and medium-sized companies throughout the nation. Here are some examples:

PAYROLL SAVINGS MAKES EMPLOYEES MORE CONTENTED

In General Motors' My Job Contest, approximately 15,000 GM men and women gave the Payroll Savings Plan as one of the reasons they like their jobs!

PAYROLL SAVINGS CUTS ABSENTEEISM

A survey made by a smaller company in Minnesota showed that during a recent three-month period employees not on payroll savings were absent almost 2½ times more frequently than those who were on the Payroll Savings Plan. Further proof that payroll savings cuts absenteeism!

PAYROLL SAVINGS REDUCES ACCIDENTS

Records at our eleven Navy Yards show that, as participation in the Bond program increases, accident frequency and accident severity decline. When participation at the Norfolk Navy Yard climbed to over 90%, accident frequency declined over 50%, and the accident severity index dropped to 1/6 its former level!

Hundreds of companies are reporting benefits like these! Obviously, they add up to increased production.

What's more, the Payroll Savings Plan is a powerful weapon against inflation. Every Savings Bond dollar built up in the Treasury retires a dollar of the national debt that is potentially inflationary. That's good for the country's future—which means it's good for *your company's* future.

And, of course, it's good for the employee's future, because the Bonds pay $4 at maturity for every $3 invested.

If your company has the Payroll Savings Plan, make sure you and your employees are getting the most out of it! If you haven't yet installed the Plan, you're missing something! For facts or help, call your Treasury Department's State Director, Savings Bonds Division.

The Treasury Department acknowledges with appreciation the publication of this message by

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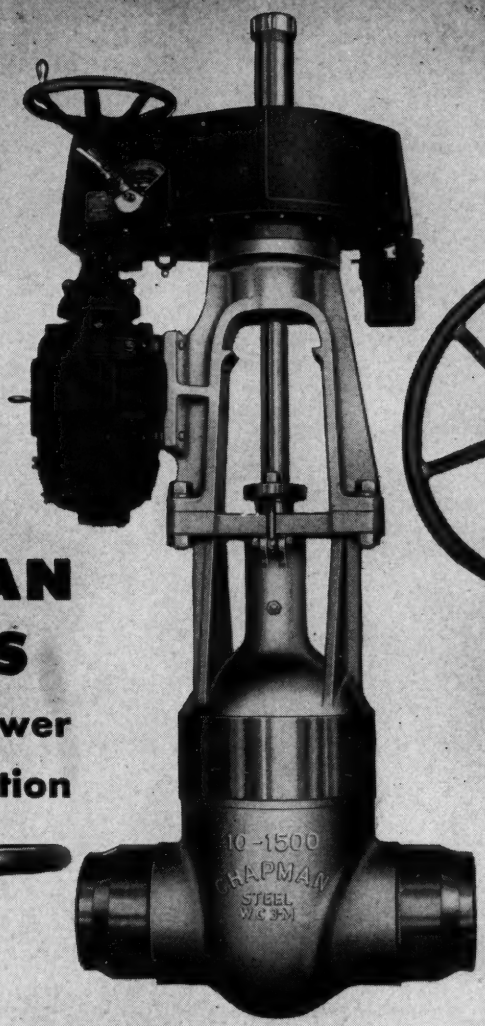

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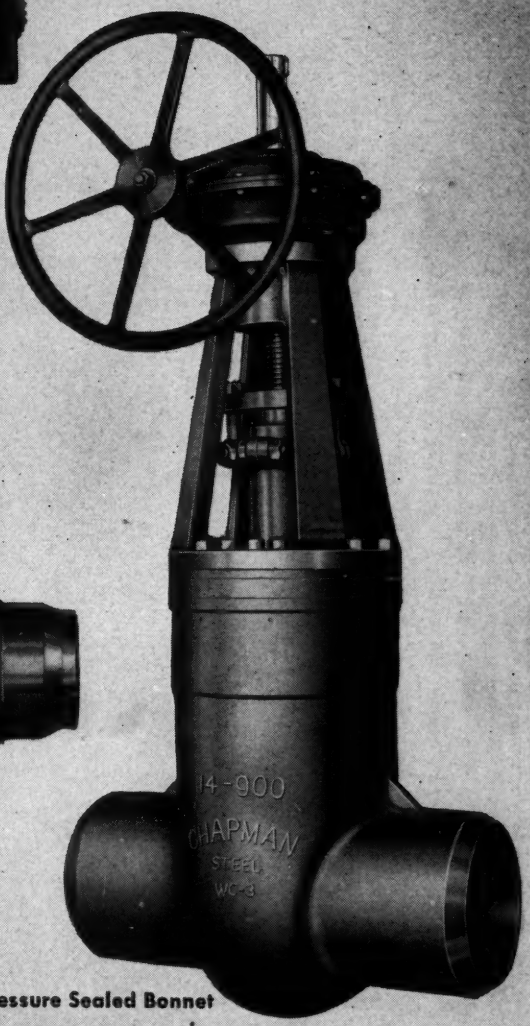

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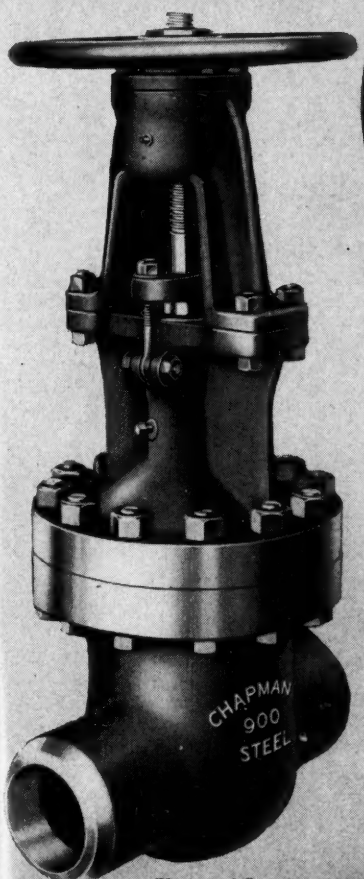

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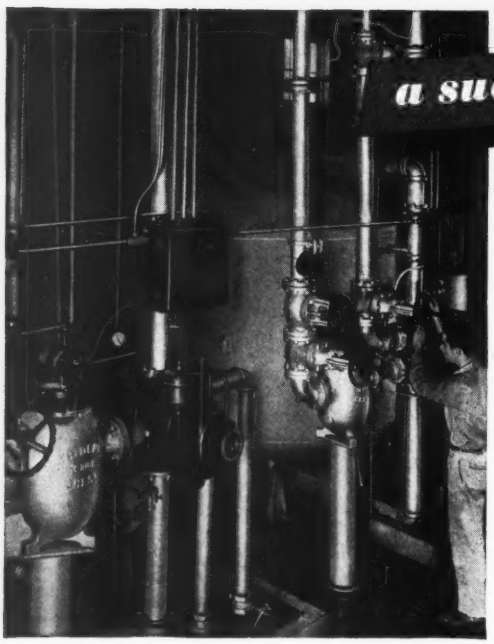

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